Municipal and County Engineering

DESIGN, CONSTRUCTION, OPERATION AND MAINTENANCE OF ALL PUBLIC WORKS

Vol. LXVI. APRIL, 1924 No. 4

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Contracts Awarded

ROADS AND STREETS

Ala., Anniston—Morgan-Hill Paving Co., Birmingham, awarded contract at $150,000 for street paving here.

Ala., Decatur—Independent Paving Co., Birmingham, awarded contract at $300,000 for approx. 110,000 sq. yds. surface street paving; pave a road asphalt, Portland cement, asph. conc. Kentucky rock asphalt, emulsified conc. asph., Warrenite bitulithic or bituminous.

Ala., Mobile—Pritchard-Raines-Hazelhurst Co., Savannah, Ga., awarded contract by City Commrs. to pave with sheet asphalt, Broad St., Texas to Baltimore, and Wash. Ave., Baltimore to Louisville & Nashville crossing, at $136,032.

Ala., Mobile—Morgan-Hill Paving Co., Birmingham, awarded contracts at $124,418 for asphaltic conc. pavement; Hancock Bros., Mobile, contract at $68,149 for one course conc. pavement.

Ala., Montgomery — McQuary Bros., Albany, awarded contract by State Highway Comm. for about 6 miles bitum. macadam betw. Decatur and Moulton, Lawrence Co., at $114,591.

D. C., Washington—McGuire & Rolfe, 1108 Va. Ry. & Power Bldg., Richmond, Va., awarded contract to resurface and renew various streets with sheet asph., at $200,000; 24,000 sq. yds. standard sheet asphalt pavement; 24,000 sq. yds. standard asphalt surface.

Cal., Bakersfield—California Constr. Co., 58 Second St., San Francisco, awarded contract for construction of the 38-mile Taft-Bakersfield-Maricopa Hwy., at $840,090.50.

Cal., Covina—Griffith Co., 502 L. A. Ry. Bldg., contract at approx. $119,000 by City Trustees for impvt. of First St., Puente Ave. to Front St., and portions of 2nd, 3rd, 4th, 5th and other streets, by grading and paving with 4-in. asphalt in 2 courses, with an asphalt paint flush coat; constructing curb, comb. curb and walk, conc. gutters, etc.

Cal., Compton—Geo. H. Oswald, 366 E. 58th St., Los Angeles, awarded contract for paving Arbutus, Terebinth, School, Magnolia and about 12 other streets, involving 730,800 sq. ft. grading at 1c ft.; 730,800 sq. ft. 5-in. conc. pavement at 17c ft.; 288 ft. curb at 50c ft.; 6 culverts at $200; total approx. $133,744.

Cal., Sacramento—Sam Hunter, Santa Barbara, awarded contract by State Hwy. Comm. for constr. of 13.5 mi. State Hwy. in Ventura Co., Camarillo to south county boundary, at $319,145. This length of 13.5 mi. will be graded and 7.4 mi. paved with cement concrete and widening of 2.5 mi. by constr. of conc. shoulders.

Cal., Sacramento—Kisselburg, Schmidt & Hitchcock, Phoenix, Ariz., awarded contract for grading and surfacing 11 miles Imperial Co. trunk line betw. San Hills and the Colorado river at Yuma, at $165,436.

Cal., Sacramento—J. P. Holland, 540 Brannon St., San Francisco, awarded contract at $181,386 for constr. of a section of the State Hwy. in San Mateo Co., Div. 4, Rte. 55, Sec. C, about 6.4 miles; grading and surfacing with crushed gravel or broken stone.

Cal., San Diego—Paul Ford, E. San Diego, awarded contract for paving 5 mi. stretch of county hwy. on Ramona Rd., Santa Maria Valley, at $131,374. Pavement is to be of cement conc. 18-ft. wide, 3-in. thick in center and 7-in. on outer 3-ft. on each side.

Cal., Santa Ana—Griffith Co., 502 L. A. Ry. Bldg., Los Angeles, awarded contract by County Supvrs. for paving in Placentia under Rd. Imp. No. 23, at $82,300.

Colo., Denver—State Hwy. Dept. let following contracts: 1.8 mi. F. A. P. 256-B. Logan Co., to W. F. Pigg & Son, Engineers' Bldg., Denver, at $53,703; grading and gravel surfacing 6.5 mi. F. A. P. 253-A, Routt Co., to Northwestern Constr. Co., Craig, at $126,375.

Fla., Lakeland—E. H. Trebes, Tampa, Fla., awarded contract by owners of Shore Acres (suburban residential section) at about $300,000 for basic impvt. work; 34 mi. cement walls and curbs; 17 mi. asphalt paved streets, including storm and sanitary sewers, water mains, elec. lighting and power lines and other impvts. Shore Acres is located about 1 mi. from Lakeland, bordering Dixie Highway.

Fla., St. Petersburg—Georgia Engineering Co. awarded contract at $1,500,000 for following street improvements: 429,425 sq. yds. new pavement; 89,840 sq. yds. relaid paving; 240,540 lin. ft. new curb and 57,490 ft. re-set curb.

Fla., W. Palm Beach—Greynolds & Monroe, Inc., W. Palm Beach, awarded contract by City Comm. to pave Belvedere Rd., Dixie Hwy. to west city limits and Southern Blvd., Dixie Hwy. to Lake Drive, at $165,109.

Fla., Wauchula—Wm. P. McDonald Construction Co., Tampa, contract by Hardee Co. Commrs. for 94½ miles hard surf. roads, at $100,000; 75 miles covered with paving surf. and 18 miles sand clay.

Ill., Springfield—Following contracts let by Department of Public Works and Buildings: W. C. Meneely Co., Decatur, Ill., Div. B, SBI Rte. 2, Christian, Shelby and Mason Cos., at $622,910; bridges to Barker & Lively, Oblong, Ill., Clay Co., Sec. 12B, SBI Rte. 12, at $6,885; SBI 24, Sec. 3, Christian Co., paving to Stevens Bros., St. Paul, Minn., $191,769; 12, 11, Clay Co., paving, Jos. Kesl & Son, Edwardsville, Ill., $219,000; SBI 31, S. 19, Fulton Co., paving to Sutton & Moore, Canton, Ill., at $61,741; SBI 9, S. 45, Peoria Co., paving to Cameron, Joyce & Co., Keokuk, Ia., $133,983; SBI 2, S. 63, Woodford-McLean Cos., paving, to L. S. Kuhn, Bloomington, Ill., $131,136; brdgs. to C. T. Laird, Pittsfield, in Pike Co., at $13,350; SBI 19, 88A, Cook Co., paving, to Northern Ill. Supply Co., Rockford, Ill., at $16,797; SBI 2, Div. A, Christian, Shelby and Fayette Cos., paving, Mautz & Oren and C. J. Moritz, Inc., Effingham, Ill., $575,947; SBI 9, S. 33, McDonough Co., Jos. Kesl & Son, Edwardsville, Ill., $177,614; bridges, to L. C. Kesler, Herrick, Ill., SBI 2, S. 20B, Fayette Co., $7,307; SBI 3, Secs. 40A, 41A and 42A, McDonough and Schuyler

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Cos., grading, to E. P. Olson, St. Joseph, Mo., at $11,702, $47,407 and $32,915; SBI 2, S. 20A, Fayette Co., to H. Edwards, McGuire, Indianapolis, Ind., at $8,670, SBI 1, Secs. 22, 23 and 24, Crawford and Clark Cos., paving, to Alan J. Parrish, Paris, Ill., at $309,020; SBI 2, Div. C, LaSalle-Lee and SBI 18, Div. A, Bureau Co., paving, to R. F. Conway Co., Chicago, Ill., at $926,000; bridge in Mercer Co., SBI 3, S. 26C, to St. Louis Struct. Steel Co., St. Louis, Mo., at $7,247; SBI 16, S. 16, Christian Co., paving, to Ind. Road Paving Co., Rochester, Ind., at $79,296; SBI 9, S. 26, Hancock Co., paving, to Cameron, Joyce & Co., Keokuk, Ia., at $109,598; SBI 12, Secs. 30, 31, 32 and A-1, St. Clair Co., pavement, to Capital Constr. Co., 1207 Cherry St., Des Moines, Ia., at $339,500; SBI 12, S. 30A, grading, St. Clair Co., to Frazier-Davis Constr. Co., St. Louis, Mo., at $9,126.36; SBI 16, S. 20A, Montgomery Co., grading, to Gaines Bros. Co., Fairland, Okla., at $30,484; SBI 8, Sec. 20, Iroquois Co., pavement, to Cast Stone Constr. Co., Eau Claire, Wis., at $243,388; SBI 16, Secs. 1 and 2, Edgar Co., to Chas. W. Clark Co., Terre Haute, Ind., at $96,631 and $147,256, respectively.

Mich., Grand Rapids—Following contracts let for impvt. of streets by City Commission: Guy A. Beckwith, contracts for impvt. of Straight Ave., Fulton to Wealthy Sts., grading and paving with sheet asphalt, at $14,681 for portion betw. Fulton and Butterworth and $11,438 for that betw. Butterworth and Wealthy; also contract for constr. of 4,500 yds. conc. walks on north side of Fulton St. and east of River, at $7,000; Vander Weele Bros. awarded contract for paving Hall St. with sheet asphalt betw. Madison and Union Avs., at $17,771; also contracts for St. George Ave., Burton St. to south end, at $15,413; Giddings Ave., Franklin to Alexander Sts., $19,714; Neland Ave., Alexander to Fisk Sts., $7,973; Maple St., Division Ave. to Jefferson Ave., $8,151; Quarry Ave., Leonard to Richmond Sts., $24,655; Guy A. Beckwith also awarded contract for paving Sinclair Ave. with sheet asph., Michigan St. to point 500 ft. north of Hastings St., at $13,730; Williams & Knowlson, awarded contracts for Griggs St., Division Ave. to Eastern Ave., at $27,625; Grigg, Division to Buchanan Aves., at $9,417; Valley Ave., Bridge to Fourth Sts., at $12,894; Valley Ave., Bridge to Fulton Sts., at $20,-154; Kloot & Son, contracts for impvt. of Union Ave., Franklin to Hall Sts., $27,564; 3rd St., Front to Stocking Ave., $16,881; Pine Ave., Bridge to Sibley, at $14,452; Third, Stocking to Valley Ave., $36,21; Union Ave., Franklin to Hall Sts., at $29,344; Diamond Ave., Eiat St. to Short St., asph. on concrete, at $20,019; Division, to Century, on Buckley, asph. on conc., at $14,092; Golden Boter Transfer Co., contract for Bristol Ave., Fourth St. to 1,100 ft. no. gravel rdwy., $4,668; McDermott & Cooper, Buchanan Ave., Hall St. to Burton St., asph. on conc., at $63,220; Vander Weele Bros., Ethel Ave., Thomas to Franklin Sts., asph. on conc., at $9,362.

Ia., Dubuque—Contract let to following for paving 14 miles (41 paving projects): 1, J. Rasmussen & Sons, Oshkosh, Wis., sheet asph., at $227,916, asph. conc., $5,928; 2, Uhlrich-Parley Co., Dubuque, vibrolithic pavement, at $250,014; 3, Jas. F. Lee Paving Co., Dubuque, sheet asphalt, at $966; 4, S. J. Groves & Sons, 306 Globe Bldg., Minneapolis, bitum. macadam, at $4,261.

Ia., Indianola—Following contracts let for grading in Warren Co.: Prim. Rd. Proj. 44-A and Norwalk Exten., 8.359 mi. prim. rd. through Norwalk S. & W. Excav. to J. C. Parquette, 2347 Capitol, Des Moines, 120,707 c.y., 24c per c.y.; guard rail, to F. N. Schwilk, Corydon, 704 ft. type C, at 54c per ft.; 776 ft. type A, 47c per ft.; 13,320 ft. type A, 17c per ft. Baffles, to Orr Constr. Co., 80 at $9 each. Prim. Rd. Proj. 321-V, 3.901 mi. prim rd.; excav., J. C. Parquette, 91,383 c.y., 24.79c c.y.; guard rail, F. N. Schwilk, Corydon, 384 ft. type C, 54.25c per ft; 424 ft. type A, 49c per ft.; 8,496 ft. type A, 17c per ft. Baffles, to Orr Constr. Co., 229 at $8.55 each.

Ia., Iowa City—Wm. Horrabin, Iowa City, awarded contract for paving and grading in various streets with either vit. brk., Warrenite bithulithic, asphalt conc., stand. sh. asph. r.c., or vibrolithic conc., at $130,000.

Ky., Louisville—Henry Bickel Co., Louisville Asphalt Co. and F. G. Bresslin, awarded contracts at about $250,000 for extensive street pavement.

Md., Towson—H. T. Campbell Sons Co., York Rd., Towson, contract for 2 sections of road in 7th Dist. as follows: 1½ mi. Grayson Rd. and 2 mi. Middletown Rd., at $96,000.

Miss., Bay St. Louis—Sam L. Boyd, Columbia, Miss., awarded contract for 2 sections gravel road, totaling 11.93 mi. from Logtown to Old Spanish Trail and from Klin to Harrison Co. line, Proj. 159, at $150,000.

Miss., Iuka—Scott & Bearden, Sparta, awarded contract by Tishomingo Co., for 17 miles gravel rd. on Lee Hwy., Alcorn Co. line to Ala. State line; Fed. Govt. to furnish $125,000, Tishomingo Co., $100,000; contract price $203,559.55.

Mo., Columbia—Short & Bramer, Monett, awarded contract by State Hwy. Dept., to improve 9 miles of road from Columbia to Rocheport, at $110,958.

Neb., West Point—Yantz Constr. Co., Omaha, awarded contract for graveling: 156,651 sq. yds. 4-in. grav. surf. at $53,837 (Proj. 172. Schlouter Bros., Freemont, awarded contract for 2grading Proj. 70-C, at $6,945; culverts to Norfolk Bridge & Constr. Co., Norfolk, at $1,719.

N. J., Morristown—Public Service Production Co., Park Pl., Newark, awarded contract for conc. paving in Morris Co., at $163,623; 47,840 sq. yds. on Long Valley-Hunterdon Co. Rd.

N. Y., New York—Park Bd. let contracts as follows: Pave and repave (asphaltic mastic walks) in Central Park, to L. Di Minna, at $29,590; grading and curbing, etc., new roadway entrance to Central Park at Sixth Ave. and 59th St.; also drain pipe in music stand in mall in park, to Fleming & Sheppard, Inc., 116 Broad St., at $20,880 and $3,673, respectively; drain pipe and completing roads and connection with constr. of Rice Memorial on Pelham Bay Parkway, to J. Paladino, Inc., at $111,742.

N. C., Statesville—R. G. Lassiter & Co., Raleigh, N. C., awarded contract for 4.1 miles asphaltic concrete on conc. base road from Mooresville toward Salisbury and Landis, at $120,000.

O., Steubenville—H. F. Dougherty, Steubenville, awarded contr. for macadam resurfacing 7.7 miles Rayland-Dillonvale Rd.; also 8.3 miles Richmond-Knoxville Rd., Jefferson Co., at $49,210 and $35,838, respectively.

Okla., Tulsa—City let contracts at $399,810.85 for paving in 20 residence districts as follows: Standard Paving Co., San Antonio, Tex., at $184,400, 5 districts; H. L. Canaday Co., at $51,120 in 3 districts; Ward Paving Co., at $48,700, 5 districts; Western Construction Co., Okla. City, Okla., at $19,-300 for 3 contracts; Tibbetts & Pleasant, Tulsa, at $77,904 to pave 11th St. from Elgin to Peoria Ave. with 56 ft. pavement.

Ore., Salem—J. C. Compton, Portland, awarded contract by State Hwy. Commission for paving 9½ miles Albany-Corvallis Hwy., at $231,632; concrete will be used.

S. C., Bishopville—General Drainage & Road Construction Co., Columbia, awarded contract for 2.6 miles State Hwy., 34, Bishopville toward Darlington; also for reinf. conc. bridge over Lynches River at $78,000.

Tenn., Blountville—Dixon Contracting Co., Box 1011, Savannah, Ga., awarded contract by State Hwy. Dept., Nashville, to grade and concrete 14.41 miles betw. Blountville and Kingsport; also 2 bridges, F. A. Projects Nos. 95 and 97, at $73,186.

Tenn., Nashville—Boyd Williams & Co., Murfreesboro, awarded contract by Dept. Hwys. & Pub. Works here, for grading and surfacing with 2½ bitum. macadam on coarse stone base, 13 miles Sparta-Warren Co. line road, 18 ft. F. A. P. 201, White Co., including vit. clay pipe and one concrete brdg., over 20 span, at $376,971.

Tex., Beaumont—Smith Bros., Dallas, awarded contract by Jefferson County, Texas, for 7.35 miles 7-ft. reinf. conc. Voth Rd., Treadway Canal toward Voth, to Hardin Co. line, at $204,755.

Tex., Canton—T. F. Larkin Constr. Co., Dallas, Tex., contract by Van Zandt Co., Commrs., for 7.1 mi. concrete road on State Hwy. No. 12, Grand Saline toward Edgewood via Fruitvale, at $136,-046.59.

Tex., Corsicana—Panhandle Construction Co., Lubbock, Tex., awarded contract to pave 12 streets here at $237,250.

Tex., Electra—Jordan Constr. Co., Plainview, Tex., awarded contract at $225,374 to pave 40 blocks of street with 30-in. vit. brick on 5-in. conc. base.

Tex., Galveston—United American Dredging Co., awarded contr. for grade raising in 152 blocks, 40th to 48th Sts., and J to U Aves., involving 3,811,000 cu. yds. sand filling, at $1,170,309.

Tex., Galveston—W. A. Kelso, Inc., Galveston, awarded contr. to pave 25th St., Ave. F to seawall, at $113,707.84.

Tex., McKinney—Tibbetts Construction Co., Mineral Wells, awarded contract by Collin Co. for 7 mi. reinf. conc. road in county, Proj. 402, at $240,000.

Wash., Olympia—State Hwy. Comn. let following contracts for road work: Conc. pavement, 6 mi. State Rd. 9, Olympic Hwy., Perry Creek west to Thurston Co. F. A. P. 141-B, to F. McLellan, Seattle, at $181,940; 4.64 mi. State Rd. No. 9, Olympia Hwy. (conc.), Grays Harbor, Thurston Co. line, east in Thurston Co. F. A. P. 141-B, to T. M. Morgan, Everett, Wash., at $172,750; clear, grade and drain abt. 7.37 mi. State Rd. 3, Inland Empire Hwy. betw. Waitsburg and Dayton, Columbia and Walla Walla Cos., to Campbell Constr. Co., Sunnyside, at $41,234; surfacing with crushed rock about 7.1 mi. Rd. No. 3, Inland Emp. Hwy. betw. Indio and Pomona, Kittitas Co., to Fred G. Redmon, Yakima, at $18,273 clearing about 6.62 mi. State Rd. 9, Olympia Hwy., Queets river southeast in Grays Harbor and Jefferson Co., F. A. Proj. 113, Sec. C, to J. Rignoll, Rignoll, Wash., at $28,679.

Wis., Port Washington—McGucken & Vanderheyden, 92 Mason St., Milwaukee, awarded contract for road work in village of Thiensville and Ozaukee Co., part full width pavement in village, at $118,793; conc. surf. 18-ft. wide, 8-in. edge, 7-in. center, 64,700 sq. yds., etc., alt. on vibro. pavement; Sec. B, Brown Deer-Cedarburg Rd., Manitowoc Constr. Co., Manitowoc, at $56,646, for road work in Cedarburg and Ozaukee Co.; conc. surf. full width. Engr. W. C. Bartlett; Asst. Engr., H. Peters.

W. Va., Bluefield—Murman Co., Knoxville, and Bodenhamer & Tabor, Bluefield, awarded contract for 6 miles one-course conc. street pavement, at $400,000.

Wis., Elkhorn—Perry Foss, Madison, awarded contracts by State Hwy. Comn. for following: Big Foot, Walworth Rd., $57,897; Walworth-Darien Rd., Sec. A, $130,854; Allen Grove-Darien Rd., Sec. B, $8,295.

Wyo., Cheyenne—Following contracts let by State Hwy. Dept.: Rawlins-Casper Rd., Rawlins to Muddy Gap, to Sherrock & Purcell, Casper, at $93-449, for grading and culverts on 32½ miles of road. Moorcroft-Carlisle Rd., Crook County: 1, Wickham Bros. & Schweiger, Billings, Mont., $56,601, for grading and culverts on 7.55 miles; 2, Midland Bridge Co., Kansas City, Mo., $10,775 for bridge. Sheridan-Buffalo Hwy., Johnson County: 1, Chas. Wagle, Ucross, $50,594 for grading and surfacing 5.84 mi.; 20, J. F. Turpin, Wheatland, $21,225 for bridge. Torrington-Morrill Rd., Goshen County: Jesse Davis, Bordeaux, $46,219 for grading and surfacing 7.62 miles.

SEWERAGE AND SEWAGE TREATMENT.

Ala., Mobile—Hancock Bros., Mobile, awarded contract for constructing storm sewers at $48,501.

Cal., Huntington Park—Joe Chutuk, 343 Wilcox Bldg., awarded contr. for constr. of new city sewer system, with out-fall intercepting sewer, at $66,400. Work involves approx. 20,000 lin. ft. vit. pipe of from 12 to 24-in. diam.

Cal., Pasadena—Heafy, Moore & McNair awarded contract for constr. of out-fall sewer betw, Pasadena sewage disposal plant and Rio Hondo River, at $118,720.

Ont., Toronto—Following contracts let by City: University Creek Relief, $86,548, to Jos. O. Jerou, 90 Curzon St. St. Johns Rd., $423; Lane e. of Ontario, $797; Lane w. of Bathurst, $497, to W. E. Taylor, 22 Falcon St., Lane s. of Royce, $583, Lane w. of Emmerson, $960, Wynchwood Ave., $3,395, to Grant Contracting Co., 50 Front St. Lane n. of Lappin, $726, to Murphy Contracting Co., 8 Wychwood Park. Tyrrell Ave., $38,993, to W. R. Worthington, 57 Lascelles Blvd.

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Ia., Clear Lake—Gjeffefald-Chapman Constr. Co.,-Forest City, awarded contract for sewage disposal plant, including brick bldg., 80x160 and 42,000-ft. san. sewers, at $104,860; C. H. Werner, Waterloo, awarded contract for constr. of plant at $49,497.

Mich., Muskegon—Hammen & Co., Detroit, awarded contracts for construction of Cedar St. sewer here, at $110,484.

Mo., Carthage—V. E. Koch, Joplin, Mo., awarded contract to construct sewage disposal plant northwest of city, at $100,842.

N. Y., Long Island City—Following contracts let: Sewers in Fisk Ave. to Duit, Inc., at $339,783; Westside and Atlantic Aves., to E. Muccinni, $2,434 and $3,028, respect. Cuthbert Pl. and Metropolitan Ave. to Green Contg. Co., 734 Vernon Ave., Astoria, at $2,461 and $5,389, respect.; Queens and Northern Blvds., to Peace Bros., Inc., 57 N. Laurence St., Flushing, at $900 and $1,145, respect.; Woodward Ave., to J. J. O'Brien, Jr., William St., Jamaica, at $729; 126th St., to P. J. Greenhoff Engrg. Co., at $1,636. Following contracts let for sewers in Queens Boro.: J. Gallo, 203 Division St., Brooklyn, at $58,953 and $3,775, respectively; 85th Rd., to D. A. Gross, at $2,364; Way Ave., to Duit, Inc., at $16,946.

N. C., Charlotte—Boyd, Higgins & Goforth, Charlotte, awarded contract for sewer construction, at $62,000.

N. C., Charlotte—J. B. McCrary Co., Atlanta, Ga., awarded contract by City Commrs., to lay 3½ miles 48-in. sewer line to new septic tank at $152,000; A. H. Guion, Gastonia, contract to construct septic tank, at $98,200.

N. C., Greensboro—C. P. Howard, Raleigh, awarded contract for laying 46 to 50 miles sewer and water mains, at $239,792.

O., Akron—L. Crane, awarded contract for sewer in W. Market St., at $36,806.

O., Ashtabula—American Constr. Co., Marion Bldg., awarded contract for 3,500 ft. 24x42-in. conc. outfall submerged pipe and river crossing, at $207,162.

O., Cleveland—Langahan Constr. Co., Marshall Bldg., awarded contract for 16,000 ft. 8-27-in. vit. clay and 3,200 ft. 30-40-in. segmental blk. sewer in Impvt. 55 of Co. Sewer Dist., at $120,746.

Va., Richmond—Following sewer contracts let by A. J. Saville, Director of Public Works: Smith Bros., main contract at about $300,000; Warner, Moore & Co., at $40,000, for segment blocks; Lock Joint Pipe Co., East Orange, N. J., at $90,000, for precast reinf. conc. pipe; Starke Dixie Plow Works, 1518 E. Gary St., Richmond, at $6,020, for castings; Eastern Brick Co., at $15,712, for sewer brick.

Wash., Kelso—J. D. Hanley, Kelso, awarded contract for concrete storm and sanitary sewers in West Kelso, L. I. D. 55, at $52,241.

Wis., Milwaukee—Metropolitan Sewerage Comm. let contracts for Cudahy Sewer Sec. 3, Barland, Allerton and Lynn Aves., conc. pipe, to H. Hohensee, Ludington Ave., Wauwatosa, at $273,229; main sewer to No. 2 outfall in Shorewood and Whitefish Bay, Milwaukee Co., to E. M. Gillet, 673 25th St., at $15,641.

Wis., Milwaukee—E. Steigerwald & Sons, 2303

Galena St., awarded contract by Sewerage Comn., 508 Market St., for superstruct. 2-sty., 220x330 ft. filter and drier house, brick and conc., at $208,449.

WATER SUPPLY AND PURIFICATION.

Cal., Gilroy—M. Murphy, 1321 Milvia St., Berkeley, contract for extensions to water system, including 4, 6, 10 and 14-in. cast iron pipe, at $63,421.

Cal., Hanford—Mike Lang & Son awarded contract by Associated Pipe Line Co. to construct 8-in. pipe line betw. Fellows and Coalinga, at 45c per lin. ft. for trenching, and laying all pipe averaging 21.5 ft. in length and 35c lin. ft. for all pipe 36 ft. in length.

Cal., Los Angeles—Grinnell Co., 439 E. Third St., awarded contract for 18,600 ft. 20-in. cast iron pipe in 4-metre lengths, at $4.39 per ft.

Cal., Santa Monica—Claude Fisher, Wright & Callender Bldg., Los Angeles, awarded contract for constr. of new water works system. Type of pipe has not yet been determined, but action will probably be taken at once, according to H. E. Elrod, of Elrod Engrg. Co. Cons. Engrs. Contr. prices submitted by Mr. Fisher are as follows: Riv. Steel pipe, $86,388; cast iron pipe, $662,495.48; De Lavaud pipe, $647,105.48; wood stave pipe, $78,-124.22.

Ind., Bloomington—A. Phelps & Sons, Knoxville, Ia., awarded contract for water works impvts., including dam, pumping station and pipe lines, at $274,894.

Minn., Duluth—Following contracts let: Water and gas spcls. to National Iron Co., 50th Ave. W. and Ramsey, Duluth, for 50,000 lbs. cast iron water and gas specials, at 4½c per lb.; one feed water boiler to C. C. Fergussen Co., Lyceum Bldg., Duluth, at $170.

Minn., Red Wing—Following contracts let for waterworks sys.: A. C. Rhodes Co., Iowa, general contract at $18,638. Excav. to C. Walter Johnson, Red Wing, $4,975. Airlift pump to Worthington Pump & Machinery Corp., 1017 Commerce Bldg., St. Paul, $4,192; centrif. pump, to F. T. Hildred & Co., 108 E. Third St., St. Paul, at $3,097.

Neb., University Pl.—(Lincoln P. O.)—Following contracts let for improving waterworks, including 500,000 gal. reinf. conc. reservoir, high lift pumping sta., 160 ft. deep well, 2,500-g.p.m. centrif. pumps, etc.; general contr. to C. C. Bickel, Univ. Pl., at $27,814; cast iron pipe to U. S. Cast Iron Pipe Co., American Trust Bldg., Birmingham, Ala., at $5,290; installing pump to Power Utilities Co., Omaha, at $2,660.

N. Y., Brooklyn—Wataga Contg. Co., awarded contract for mains in Ave. L, 2nd Ave., 37th, 42d, Bridge, Sands and Clinton Sts., at $129,756. Paladino Contg. Co., 437 E. 120th St., New York, contract for mains at $32,235, in various streets.

N. Y., Gloversville—E. P. Tupfer Corp., 592 Ellicott Sq., Buffalo, awarded contract by Bd. Water Commrs., 19 W. Fulton St., Ayers Hill Reservoir; 21,300 c.y. earth and 100 c.y. rock excav., 350 c.y. screened gravel, 52,000 lbs. reinforcing bars, 10,400 lin. ft. expansion joint, 100 ft. sewer pipe, etc., at $56,820.

N. Y., New York—Following contracts let for water mains: Riverside Terrace, Bennett and 12th Aves., W. 12th, W. 40th, 46th and 186th Sts.; also fire hydrants on existing mains in Ave. A, Broadway, E. Broadway, Riverside Dr., Bayard, James, Madison, Oak, Water and W. 153rd Sts., to W. J. Drummond, at $41,781.

N. Y., Palmyra—T. Fischette, Clyde, awarded contract by Bd. Village Trustees for waterworks impvts., Sec. A at $23,625, Sec. B $10,373, Sec. C at $7,293.

N. C., Greensboro—Paul Howard, awarded contract by city to lay 51 miles sewer and water pipe at $262,000.

O., Dayton—Following contracts let for water supply system in Overlook Dist. to Crumley, Jones & Crumley, 2301 Concord St., Cincinnati, at $147,-470;; Lower Belmont Dist. to F. Krumholz, Springfield, at $134,280; Upper Belmont Dist. to C. J. Wetzel, Dayton, at $126,350.

O., Lorain—Paterson Supply and Constr. Co., Broadway, awarded contract for conc. filter beds, 100,000 lbs. steel and 860 c.y. conc. at $36,000.

Okla., Canton—Dohe & O'Keefe has contract for water and electrical works at $30,000.

Okla., Holdenville—Votaw & Lang, Holdenville, awarded contract for waterworks impvts. at $64,-518.12.

Okla., Nowata—Sherman Machine and Iron Wks., Okla. City, awarded contracts for water works impvts. consisting of 1,000,000-gal. reinf. conc. reservoir, pumping station, two 500,000 gals. P. D. rapid sand mechanical filters complete with low and high service pumps, and pipe connections, at $68,240.

Okla., Okla. City—Callahan Construction Co. awarded joint contr. for excav., and Smith Bros., Dalias, Tex., contract for cement and dam, at $794,575.

Pa., Philadelphia—R. D. Wood, 400 Chestnut St., awarded contract by Dept. Pub. Wks. for furnishing 2,500 tons 6, 8 and 12-in cast iron pipe at $168,000.

S. C., Hartsville—Davis Construction Co., Atlanta, Ga., awarded contract for electric pumping plant, including installation of 500,000-gal. reservoir and extension to water mains and sewerage system, at $51,785.

Tex., Corsicana—Mitchell Constr. Co., Abilene, awarded contr. for spillway at $48,684 filters to International Filter Co., 333 W. 25th Pl., Chicago, at $21,200.

Tenn., Gallatin—City let following contracts for water works impvts.: Sherman Machine & Iron Works Co., Okla. City, for general contract; Buford, Hall & Smith, pumps and motors; plant will consist of gravity type filter plant of 750,000 gal. capacity; cost $35,000.

Tex., Kerrville—Elder Construction Co., 235 Moore Bldg., San Antonio, awarded contract for installing water system and sewage disposal plant at $78,000.

Wis., Portage—J. M. Allmendinger, Bentor Harbor, Mich., awarded contract for filter plant station, 41,500,000 gal. capy., reinf. conc. and brick, 2 stories, at $100,000.

Wyo., Casper—Casper Supply Co. awarded contract for pipe for water works extensions, at $47,000.

Prospective Work

ROADS AND STREETS.

Ala., Birmingham—Jefferson Co. Hwy. Dept. plans to bld. 3 rd. sections—16 miles, from Birmingham to Warrior; 7 miles, Montgomery Hwy., top of Shades Mtn. to Cahasa River brdg.; 1 mi., from Huffman to Roebuck $940,000 available; also plans 4 additional roads as follows: 14 miles road, from Pt. Pinson to Vil. Springs; 13 mi., from Birmingham to Argo; 12 mi., Bankhead Hwy., from Adamsville to Walker Co. line; 12 miles, from Birmingham to Leeds.

Cal., Pomona—City plans to pave 5th St. to exceed in cost $100,000; W. Holt St., $28,000; resurfacing E. Holt St., $20,000 widening same, $11,186; resurfacing S. Gary St., $11,550. F. C. Troehde, City Engr.

Cal., San Francisco—Board of Public Works has adopted resolution of expediency authorizing $110,-000 impvt. of Judah St., 31st to 41st Aves. Grading and paving of street will permit constr. of Judah street extension of Municipal Railway. Impvt. of 5 blocks on Vicente St., at approx. cost of $50,000, also approved.

Cal., San Luis Obispo—Engineers Burch and Beck, San Luis Obispo, have been retained by Joint Hwy. Dist. No. 2, consisting of Santa Barbara, San Luis Obispo and Korn Cos., to make survey and prepare plans for grading 40 miles of road; also construction of bridges and drainage works. Proposed road runs along Santa Maria River betw. Maricopa and Santa Maria.

Cal., Yreka—Siskiyou County has appropriated $25,000, Shasta County (Redding) $12,500 and U. S. Bureau of Public Rds. $12,500 for impvt. of Sisson-Falls River Rd.

Fla., Bartow—Polk Co. Special Rd. and Bridge Dist. No. 3 plans bldg. 11 roads, totaling 52 miles; $615,000 bonds voted. W. S. Wey, Secy.

Fla., Miami—Dade Co. plans bldg. county's unit of Overseas Hwy., Key West to Mainland, from

BUYERS' GUIDE

Aerial Tramways.
American Steel & Wire Co.

Air Lift Pumps.
Harris Air Pump Co.

Armor Plates.
Truscon Steel Co.

Asphalt.
Bitoslag Paving Co.
The Barrett Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Asphalt Paving Co., The

Asphalt Filler.
The Barrett Co.
Bitoslag Paving Co.
Standard Oil Co. (Indiana)
The Texas Co.
Warren Bros. Co.

Asphalt Floors.
The Barrett Co.
The Texas Co.
Warren Bros. Co.

Asphalt Machinery.
Chausse Oil Burner Co.
Cummer & Son Co., The F. D.

Asphalt Plants.
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
Littleford Brothers.
Warren Bros. Co.

Asphalt Railroad Plants.
Cummer & Son Co., The F. D.
Warren Bros. Co.

Asphalt Tools.
Chausse Oil Burner Co.
Littleford Brothers.
Warren Bros. Co.

Asphalt Tool Wagons.
Chausse Oil Burner Co.
Littleford Brothers.

Auto Fire Apparatus.
Kissel Motor Car Co.
International Motor Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Back Fillers.
Austin Machinery Corporation.
Pawling & Harnischfeger.

Bar Cutters and Benders.
Koehring Machine Co.

Bars, Reinforcing.
Truscon Steel Co.

Binders, Road.
The Barrett Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Bros. Co.

Bitulithic Pavements.
Warren Bros Co.

Blasting Accessories.
E. I. du Pont de Nemours & Co., Inc.

Blasting Powder.
E. I. du Pont de Nemours & Co., Inc.

Bodies.
Lee Trailer and Body Co.
Littleford Brothers.

Braces, Extension.
Kalamazoo Fdy. & Machine Co.

Brick Rattlers.
Olsen & Co., Tinius.

Brick-Testing Machinery.
Tinius Olsen Testing Mach. Co.

Bridges.
Lewis-Hall Iron Works.

Buckets, Dredging, Excavating and Sewer.
Pawling & Harnischfeger.

Buckets, Dumping.
Littleford Brothers.
Pawling & Harnischfeger.

Cableway Accessories.
Sauerman Bros.

Cableway Excavators.
Sauerman Bros.

Calculators.
Kolesch & Co.

Car Unloaders.
Austin Machinery Corporation.
Heltzel Steel Form & Iron Co.

Castings.
U. S. Cast Iron Pipe & Fdy. Co.

Cast Iron Pipe.
U. S. Cast Iron Pipe & Fdy. Co.

Catchbasins.
Dee Co., Wm. H.
Madison Foundry Co.

Cement Testing.
Kirschbraun, Lester.

Cement Testing Machinery.
Tinius Olsen Testing Mach. Co.

Central Heating Plants.
American District Steam Co.

Chimneys, Concrete.
Truscon Steel Co.

Chimneys, Steel.
Lewis-Hall Iron Works.
Littleford Brothers.

Chloride of Lime.
Pennsylvania Salt Mfg. Co.

Chutes, Concrete.
Heltzel Steel Form & Iron Co.
Littleford Brothers.

Concrete Mixers.
Austin Machinery Corporation.
Koehring Machine Co.
Smith Co., T. L., The

Concrete, Reinforcement.
American Steel & Wire Co.
Truscon Steel Co.

Conduits.
Cannelton Sewer Pipe Co.
Carey Co., Philip, The.
Truscon Steel Co.

Conduit Rods.
Stewart, W. H.

Consulting Engineers.
Alvord, John W.
Artingstall, Wm.
Brossman, Chas.
Burd & Giffels.
Chicago Paving Laboratory.
City Wastes Disposal Co.
Dow & Smith.
Fargo Engineering Co.
Flood, Walter H., & Co.
Hill, Nicholas S., Jr.,
Howard, J. W.
Hunt & Co., Robert W.
Jones, Sam L.
Kirchoffer, W. G.
Kirschbraun, Lester.
Luten, Daniel B.
Potter, Alexander.
Van Trump, Isaac.
Wells, James P.

Contractors.
City Wastes Disposal Co.
Sullivan, Long & Hagerty.
Warren Bros. Co.

Contractors' Tools and Machinery.
Austin Machinery Corporation.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.
Koehring Machine Co.
Littleford Bros.
Smith Co., T. L., The

Contractors' Wagons.
Austin Machinery Corporation.
Austin-Western Road Machinery Co.

Conveying Machinery.
Mead-Morrison Mfg. Co.
Pawling & Harnischfeger.
Portable Machinery Co., Inc.
Webster Mfg. Co.

Cranes and Hoists.
Austin Machinery Corporation.
Heltzel Steel Form & Iron Co.
Pawling & Harnischfeger.

Creosote.
The Barrett Co.
Republic Creosoting Co.

Creosoted Wood Block.
(Factory Floors, Bridge Floors)
Republic Creosoting Co.

Crushers, Rock and Ore.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Culvert Pipe, Vitrified.
Cannelton Pipe Co.
Dee Clay Mfg. Co., Wm. H.

Culverts.
Austin-Western Road Machinery Co.
Newport Culvert Co.
Truscon Steel Co.

Curb and Gutter Forms.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Curb Bar.
Truscon Steel Co.

Direct Oxidation Process.
Direct Oxidation Process Corp.

Drag-Line Excavators.
Austin Machinery Corporation.

Drag Scrapers.
Austin-Western Road Machinery Co.

Drain Tile.
Dee Clay Mfg Co., W. H.

Drawing Materials.
Kolesch & Co.

Dryers.
Cummer & Son., The F. D.

Dump Cars.
Austin-Western Road Machinery Co.

Dump Wagons.
Austin-Western Road Machinery Co.

Florida City, to connect with Key Largo Rd. being built by Monroe Co. Tentative plans are being made for new E. Dixie Hwy., city limits to Broward Co. line; completing Tamiami Trail; completing present Ingraham Hwy., Miami to Florida City; widen viaducts on present causeway. Contemplates $1,000,000 bond issue.

Fla., Seabreeze—City plans various municipal improvements. Contemplates bond issues as follows: $110,000 to pave streets betw. Auditorium Blvd. and University Blvd.; $35,000 for water works impvts.; $20,000 for town hall and fire station.

Ida., Boise—Cost of constr. of 7th St., Bannock st. to new main line station on beach, est. at $419,947. Included in estimate is bridge across river to cost $175,000. C. C. Stevenson, City Engr.

Ida., Boise—State Hwy. Engr. Gregory reports that bids will be called in near future on following roads: No. 77, 4 mi. Boundary Co., $65,000; Nos. 71 and 81, 4 mi., Bonner Co., $110,000; No. 73, about 27 mi., Shoshone Co., $600,000; No. 75, brdg. and overhead, nr. Potlatch, $16,000; No. 67, 3 mi., at Lapwai, Spaulding, $30,000; No. 82, 3½ mi., nr. Viola and Moscow, $25,000; No. 28C, 14½ mi., Hansen-Murtaugh, Twin Falls Co., $25,000; No. 76, 8 mi., Murtaugh-Burley, Camas Co., $65,000; No. 78, 10½ mi., Pocatello, 10-ft. Hall paving, $350,000; No. 76, 9 mi., Stites-Harpster, $110,000; 8 mi., Kooskia-Kamiah, $115,000; No. 27, 2 mi. paving, Payette, Fruitland, $50,000. In addn. Bureau of Pub. Rds. will probably let contracts in near future for the following: Bonners Ferry-Moyle Falls, $30,000; Harpster-Elk City, $75,000 4th of July Canyon, $50,000; Gardena-Horseshoe Bend, $65,000; Victor-Irwin Rd., $53,500; Lolo Pass Sec., $100,000; Ketchum-Clayton, $50,000, Soda Springs-Freedom, $16,000.

Ida., Homer—Claiborne Parish plans to construct 90 miles hard surf. roads. Contemplates $750,000 bond issue.

Mont., Missoula—Bureau of Public Roads has begun location survey of Tarkio Flats Rd., construction of portion of which was provided for at a conference in Helena. Road will be built under supervision of Bureau Pub. Rds. Road is portion of Yellowstone Trail.

Neb., Nebraska City—City will pave about 70 blocks this spring, about 86,950 yds. Chas. Shannon, City Engr.

Tenn., Alton Park Branch (Chattanooga)—City plans to lay about 1½ miles curbs and gutters on various streets.

Tex., Batesville—$165,000 bonds voted by Zavalla County, Precinct No. 4, La Pryor Dist., for bldg. State Hwy., Uvalde to Eagle Pass via La Pryor. N. P. Hunt, Co. Judge, Aransas Pass, Tex.

Tex., Colorado—City plans to pave with concrete base, bitulithic topping, 9 additional blocks in business district, including extensions on Main, Oak and Walnut Sts.

Tex., Denison—City plans permanent pavement as follows: Retop 11 blocks; pave 17 blocks and 12 alleys; total cost $195,000. Property owners to pay three-quarters of cost. R. G. Gresham, City Secy. G. E. Haydon, Engr.

Tex., Falrurrias—Brooks County plans to improve and hard surface 2 roads as follows; North and south road in county leading into Rio Grande Valley; 10 miles gravel road being built from Falfurrias toward Kingsville and Corpus Christi; $250,000 bonds voted. T. R. Spencer, Div. Engr., State Hwy. Dept.

Tex., Gonzales—Gonzales County is considering constr. of 20 miles Nixon-Smiley Rd. of Glacier-to-Gulf Hwy.; $125,000 bonds voted.

Tex., Vernon—Wilbarger County voted $150,000 bonds for grading and reinf. conc. paving, 5 miles State Hwy. 5, Harrold Precinct, 18 ft. Est. cost $150,000. J. B. Nabors, Co. Engr.

Wash., Raymond—Paving of Duryea and 3rd Sts. in near future is contemplated. Est. cost $67,828. Choice of material to be left to contractor.

SEWERAGE AND SEWAGE TREATMENT.

Ala., Birmingham—City will expend $273,000 for constr. of sanitary sewer system in business district. Bids will be received on brick and concrete sewers.

Cal., Arroyo Grande—Engineers Burch & Beck, Commercial Bank Bldg., San Luis Obispo, have been commissioned by city trustees to make preliminary survey and to prepare estimates of cost for sewerage sys. and disposal works for Arroyo Grande.

Cal., Burbank—F. Curt Miller, City Engr., is preparing plans for new sewer system in Burbank, including disposal system by the farm plan. Olmsted & Gillelen, Hollingsworth Bldg., Los Angeles, Cons. Engrs.

Cal., Los Angeles—Resolution of intention adopted by County Supervisors for formation of County Sanitation District No. 4, embracing territory in neighborhood of Doheny Ranch Tract and Laurel Canyon Annex, betw. L. A. city limits and east city limits of Beverly Hills. A. M. McPherron, Deputy Clerk of Board.

Cal., Pomona—City Engr. F. C. Froehde preparing prelim. plans for proposed $100,000 sewer system. Elrod Engineering Co., 209 Mills-Fraser Bldg., Santa Monica, will install sewage disposal plant.

Cal., Tulare—Proposed bond issue for sewer system will probably be for not less than $200,000. City Mgr., Geo. Lewis.

Ont., Bridgeburg—Plans being prepared for 16,000 ft. san. sewers, vit. tile pipe, 8-in. and up, $6,000. James, Proctor & Redfern, 36 Toronto St., Toronto, Engrs.

Ont., Long Branch—Etobicoke Twp. (Islington) having plans prepared for sewerage system here; 60,000 lin. ft. vit. tile pipe, 8-in. and up, $250,000. James, Proctor & Redfern, 36 Toronto St., Toronto, Cons. Engrs.

Ont., Toronto—Board of Control has plans drawn for laying of sewer in Fleet St. Est. cost $89,930.

D. C., Washington—Wash. San. Sewerage Comn. plans to expend $500,000 for completion of sewerage system in Maryland just outside Dist. of Col. line.

Ga., Atlanta—City Bond Comn. voted $100,000 appropriation to extend Lloyd St. sewer, $65,000 to extend Orne St. sewer.

Ia., Edgewood—Plans being prepared for san. sewerage system 3.5 miles 8 to 10-in. pipe, disposal plant, etc. Est. cost $40,000. W. E. Buell & Co., 205 Davidson Bldg., Sioux City, Cons. Engrs.

Ia., Marshalltown—City considering laying 58,290 lin. ft. 6 to 10-in. vit. san. sewers; 87 manholes, 40 lampholes, etc.; $100,000. O. G. Hern, City Engr.

Md., Glenburnie—Anne Arundel County San. Comn. has petitioned Public Service Commission for permission to issue $39,000 bonds for san. sewers and exten. of water mains.

Mich., Flint—City considering completing interceptor sys., $174,000; construct sewage pumping sta., $144,000; sewage force main, $455,400; disposal plant and filtration tanks, $1,204,800. G. M. Osborne, City Engr.

Mo., St. Louis—Citizens' Supervisory Bond Issue Comn., has approved expendts. of $113,500 for repairs to southern sewer; also $20,000 for sewer extension work.

Neb., Fremont—Will take bids in April for laying 42,000 lin. ft. 21 and 21-in. pipe for outfall sewer. Work includes manholes and siphon. L. M. Roessler, City Engr.; J. Rex Henry, Chm. Bd. Pub. Wks.

O., Euclid—Will receive bids this spring for sewers in Lloyd Rd., Shore View and Coulter Aves., Clifton and E. 213 Sts. Est. cost $100,000. F. A. Pease Engrg. Co., Marshall Bldg., Cleveland, Cons. Engrs.

Pa., Johnstown, Pa.—City plans san. sewers in Moxham and Woodvale Districts. Est cost $500,000; will be voted on in April. H. L. Wilson, 184 Worth St., Cons. Engr.

Pa., Philadelphia—Plans being prepared for 35,765 ft. sewers in Erie, Cranford, 76th, Mifflin, Wishahickon, Ithan, Tioga, Sanger, Tyson, Cottman, Winghocking, Government and Bingham Aves.; J. Pocker, Oak Lane, Venango, Rock Run, Oakland, Benner and 6th Sts. Est. cost $2,360,000.

R. I., Woonsocket—New sewers planned for various sections of city. Est. cost $500,000. City Engrs. Dept., City Hall.

Tex., Floyada—$60,000 bonds voted for constr. of sewer system and impvts. to water works.

Wash., Pullman—Plans to improve sewerage system. May issue bonds in amt. of $70,000. M. K. Snyder, City Engr.

Wis., Columbus—Will probably receive bids in May for about 2 miles 8 and 10-in. pipe. W. H. Reichardt, Engr., Watertown; W. H. Pietzner, City Clerk.

Wis., Madison—Plans being made for sewage disposal plant including grit chamber, grease extractor, Imhoff tanks, sludge beds, dosing tanks,

BUYERS' GUIDE

Dust Laying Compound.
The Barrett Co.
Standard Oil Co. (Indiana)
The Texas Co.

Dynamite.
E. I. du Pont de Nemours & Co., Inc.

Edge Protector.
Truscon Steel Co.

Electrical Wires & Cables.
American Steel & Wire Co.

Elevating Graders.
Austin-Western Road Machinery Co.

Elevators.
C. H. & E. Mfg. Co.

Engineering Instruments.
Kolesch & Co.
Lufkin Rule Co., The

Engines.
C. H. & E. Mfg. Co.

Excavating Machinery.
F. C. Austin Machinery Co.
Pawling & Harnischfeger.
Sauerman Bros.
Smith Co., T. L., The

Expansion Joint Compound.
The Barrett Co.
Carey Co., Philip, The
Pioneer Asphalt Co.
Truscon Steel Co.

Explosives.
E. I. du Pont de Nemours & Co.

Fence, Iron.
Cincinnati Iron Fence Co.

Fillers (Paving Joint).
The Barrett Co.
Carey Co., Philip, The.
Pioneer Asphalt Co.
The Texas Co.

Fire Brick.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Flue Liners.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Forms, Sidewalks, Curb & Gutter.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Forms, Road.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Forms (Sewers & Conduits).
Heltzel Steel Form & Iron Co.

Forms (Wall Bldg., Construction, Etc.).
Heltzel Steel Form & Iron Co.

Gas Pipe.
U. S. Cast Iron Pipe & Fdy. Co.

Graders.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Granite Block.
Granite Paving Block Mfrs. Assn. of the U. S., Inc.

Gravel Screener and Loader.
Good Roads Machinery Co., Inc.
Jordan & Steele Mfg. Co., Inc.

Heaters (Rock and Sand).
Littleford Bros.

Heating Plants, Central.
American District Steam Co.

Heating Wagons (Oil and Tar).
Good Roads Machinery Co., Inc.
Littleford Bros.

Hoists (Concrete, Gasoline and Hand).
Pawling & Harnischfeger.

Hoists, Electric.
Mead-Morrison Mfg. Co.
Pawling & Harnischfeger.

Hoists, Steam.
C. H. & E. Mfg. Co.
Lewis-Hall Iron Works.
Mead-Morrison Mfg. Co.

Hot Mixers.
F. C. Austin Machinery Co.

Incinerators.
William F. Morse.

Inlets (Sewer).
Dee Co., Wm. E.
Madison Foundry Co.

Insulating Material.
The Barrett Co.
Pioneer Asphalt Co.

Joint Fillers (Paving).
The Barrett Co.
Carey Co., Philip, The.
The Texas Company.

Kettles (Portable).
Cummer & Son Co., The F. D.
Good Roads Machinery Co., Inc.
Littleford Brothers.

Manhole Covers.
Madison Foundry Co.
Dee Co., Wm. E.

Mastic.
The Barrett Co.
Pioneer Asphalt Co.

Meter Boxes.
McNutt Meter Box Co.

Mixers, Asphalt.
Austin Machinery Corporation.
Cummer & Sons Co., The F. D.

Mixers, Concrete.
Austin Machinery Corporation.
Koehring Machine Co.
T. L. Smith Co.

Mixers—Mortar.
C. H. & E. Mfg. Co.

Molds (Pipe & Culvert).
Heltzel Steel Form & Iron Co.

Motor Fire Apparatus.
Acme Motor Truck Co.
Duplex Truck Co.
Federal Motor Truck Co.
Garford Motor Truck Co.
International Motor Co.
Kissel Motor Car Co.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Motor Trucks.
Acme Motor Truck Co.
Duplex Truck Co.
Federal Motor Truck Co.
International Motor Co.
Kissel Motor Car Co.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Motor Truck Flushers, Sprinklers and Oilers.
Acme Motor Truck Co.
Austin Machinery Corporation.
Duplex Truck Co.
Federal Motor Truck Co.
Garford Motor Truck Co.
The Gramm-Bernstein Motor Truck Co.
International Motor Co.
Kissel Motor Car Co.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Municipal Castings.
Dee Co., Wm. E.
Madison Foundry.

Packing.
Pioneer Asphalt Co.

Paints (Asphalt).
Barrett Co., The
Pioneer Asphalt Co.

Paving Blocks (Creosoted).
The Barrett Co.
Republic Creosoting Co.

Paving Brick.
Medal Paving Brick Co.
Metropolitan Paving Brick Co.
Murphysboro Paving Brick Co.
National Paving Brick Mfrs. Assn.
Springfield Paving Brick Co.

Paving Contractors.
Warren Bros. Co.

Paving Joint Compound.
The Barrett Co.
Carey Co., Philip, The.
Pioneer Asphalt Co.
The Texas Company.

Paving Joint Filler.
The Barrett Co.
Carey Co., Philip, The.
Pioneer Asphalt Co.
The Texas Company.

Paving Machines.
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
East Iron & Machine Co., The
Warren Bros. Co.

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Good Roads Machinery Co., Inc.

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E. I. du Pont de Nemours & Co., Inc.

sprinkling filters, secondary settling tank. Est. cost $840,000. Pearse, Greeley & Hansen, 39 W. Adams St., Chicago, Cons. Engrs.

Wis., Menomonee Falls—Plans being made for 1 mile 8-15 in. sewers and 1 mile 6-12 in. cast iron mains in various streets; also sewage disposal plant, and elev. steel water tank. W. F. Reichardt, 109 Main St., Watertown, Engr.

WATER SUPPLY AND PURIFICATION.

Ala., Albany—Alabama Water Co., 1012 Amer. Trust Bldg., Birmingham, Ala., will issue $500,000 bonds for repair and construction of present and future water plants in Alabama cities.

Ala., Birmingham—Birmingham Water Works Co. will expend $120,000 for constr. of a 16-in. additional water main through West End and Central Park.

Ala., Tuscaloosa—City contemplates early expenditure of $150,000 and an aggregate expenditure of $250,000 in next 5 years for water works system. Plans and survey by Morris Knowles, Inc., Engrs., Pittsburgh, Pa.

Cal., Beverly Hills—The $150,000 bond issue for completion of the water system carried at recent election.

Cal., Big Bear Valley—Bear Valley Utility Co., Pine Knot, Cal., is preparing to construct water works system to supply Big Bear Valley, serving approx. 20,000 inhabitants during summer. Chester H. Loveland, Engineers, San Francisco, are the engineers on the project. Work will involve about 6 miles of pipe line, consisting of 4-in. to 12-in. riveted steel pipe; 2 wells with well casing; 2 pumps, conc. reservoir of 250,000 gal. capacity. Est. cost $115,000. Bids will be taken in about a month on segregated contracts for pipe, laying of same, constructing reservoir—all under direction of R. H. Nicholson, 1350 Orange St., Los Angeles.

Cal., Culver City—Olmsted & Gillelen, Hollingsworth Bldg., Cons. Engrs., and are preparing plans and specfs. for water works system for Culver City under a $300,000 bond issue.

Ont., Can., South Porcupine—Water works proposed that will run main from the Mattagami River in easterly direction to supply towns of Schumacher and McIntyre, Porcupine mine, thence to town of South Porcupine by way of Goodale property; branches extending south into Dome area and north to Porcupine-Davidson mine. Estimated cost $750,000.

Fla., Miami—City Commrs. authorized Ernest Cotton, Director of Pub. Utilities, to purchase materials necessary for constr. of 8-mile line of redwood conduits from Hialeah to Miami. Est. cost about $245,000. May install water softening plant later.

Fla., Cocoa—City will install water works and sewerage system; $200,000 available.

Ill., Monmouth—$90,000 bonds approved by City for water works impvts., extensions, etc.

Neb., Kearney—Burns and McDonnell Engrg. Co., Kansas City, Mo., retained as Cons. Engrs., for $130,000 new water works plant. Includes oil-driven semi-Diesel engine. M. E. Burke, City Clk.

Okla., Newkirk—City will extend and improve water works; construct wells, reservoir and approx. 5 miles 10-in. cast iron pipe. Musso & Gayle, Engrs., Grain Exchange Bldg., Okla. City.

Ore., No. Bend—Coos Bay Water Co. will install new water main here extending abt. 1½ miles from the Ferndale store. Est. cost abt. $100,000.

Ore., Salem—Four applications filed with State Engrg. Dept. for authority to appropriate water from Clear Lake and no. fork of McKenzie River for water supply for Salem, Albany, Eugene, Springfield, Independence, Harrisburg, Junction City, Creswell, Coburg and other Williamette Valley towns. Supply line 179 miles in length will be required. Est. cost from $6,000,000 to $7,000,000. Men making application are: Waldo Anderson, C. C. Hall, W. S. Richards and Robt. L. Burkhart.

S. C., Summerton—Town considering installation of water and sewer system. $75,000. Tomlinson Engrg. Co., Engrs., Columbia, S. C.

Tex., Beaumont—City having plans prepared by Burns and McDonnell, Cons. Engrs., 402 Interstate Bldg., Kans. City, Mo., for filtration plans of 12,000,000 gals. capy.

Tex., Dallas—Construction will soon start on water reservoir here. $5,000,000 available. Initial cost, $2,000,000; has site on Elm Fork of Trinity River, abt. 26 miles northwest of Dallas; dam will be 55 ft. high, impounding abt. 70,000,000 gals. of water; of earth constr., principal part of which will be 2 mi. long, sheet steel piling will be used as cut-off walls across the valley. Principal structures will be outlet gates and service spillway which will be of concrete. Nagle & Thompson, Cons. Engrs., 2003½ Main St., Dallas, making final plans and will also supervise construction. Will be ready to let contracts in about 90 days. No contracts of any kind have been let. Two years will be required to complete work.

Tex., Floresville—Plans being prepared by Municipal Engrg. Co., 715 Praetorian Bldg., Dallas, for water works impvts., including reservoir, new pumps and engines and extension of mains. Est. cost, $70,000. Will vote in April on bonds.

Utah, Price—Water works impvt. program involves outlay of about $43,000. Includes renewal of 7,000 ft. pipe, etc. J. W. Plant, Supt.

Wash., Kelso—Report of Baar & Cunningham, Cons. Engrs., Portland, on proposed local water sys., presented to City Council and accepted. They recommend that $250,000 be provided by immediate bond issues to take up $40,000 in outstanding water utility bonds, $8,000 in warrant indebtedness and to provide for filtration system to cost $28,350; constr. of 2,000,000 gal. reservoir, $41,605 and installation of distributing and other mains. This bond issue would also provide $20,000 for future extensions. Complete extens. outlined in report are est. to cost $373,140 if cast iron is used; $309,691 if steel pipe is used and $250,151 if wood pipe is used.

W. Va., Morgantown—West Va. Utilities Co., 50 Pine St., New York, reported to have authorized expenditure of $250,000 for bringing mountain water to the City; will construct water mains from Cheat River watershed to Morgantown; install line 9 mi. in length. J. K. Buchanan, Local Supt.

Wis., No. Milwaukee—Plans being made for 1½ miles 6-in. cast iron mains. H. C. Webster, M. & M. Bank Bldg., Milwaukee, Cons. Engr.

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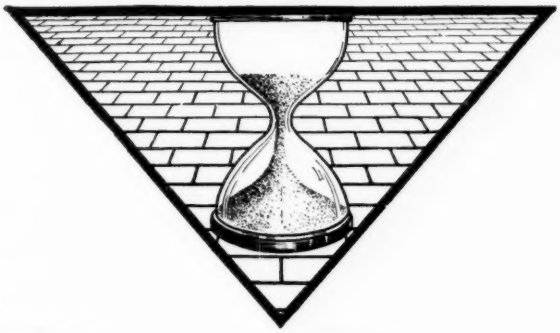

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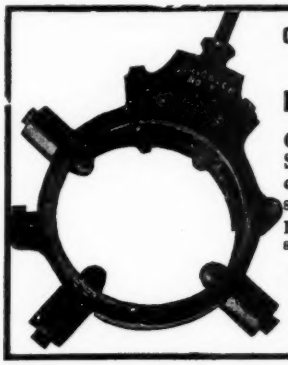

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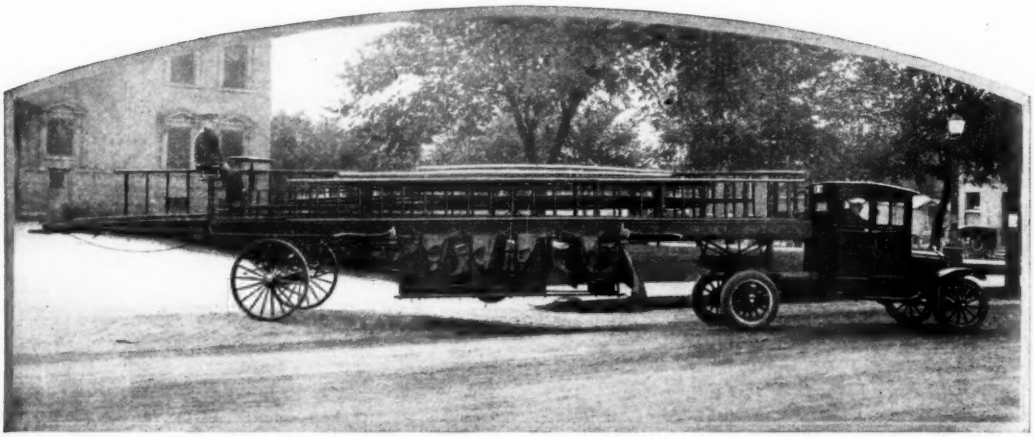

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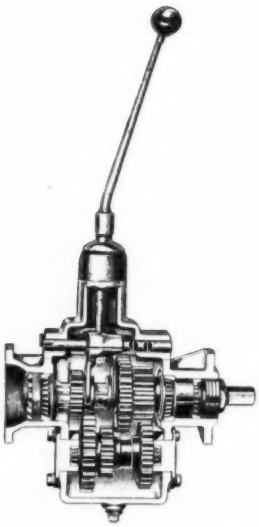

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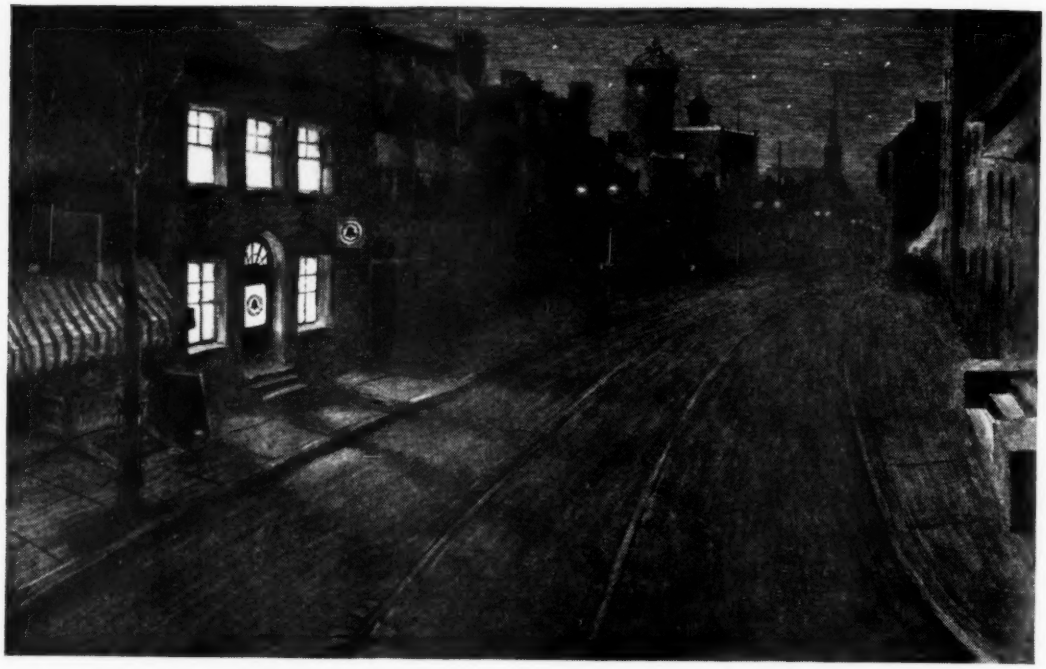

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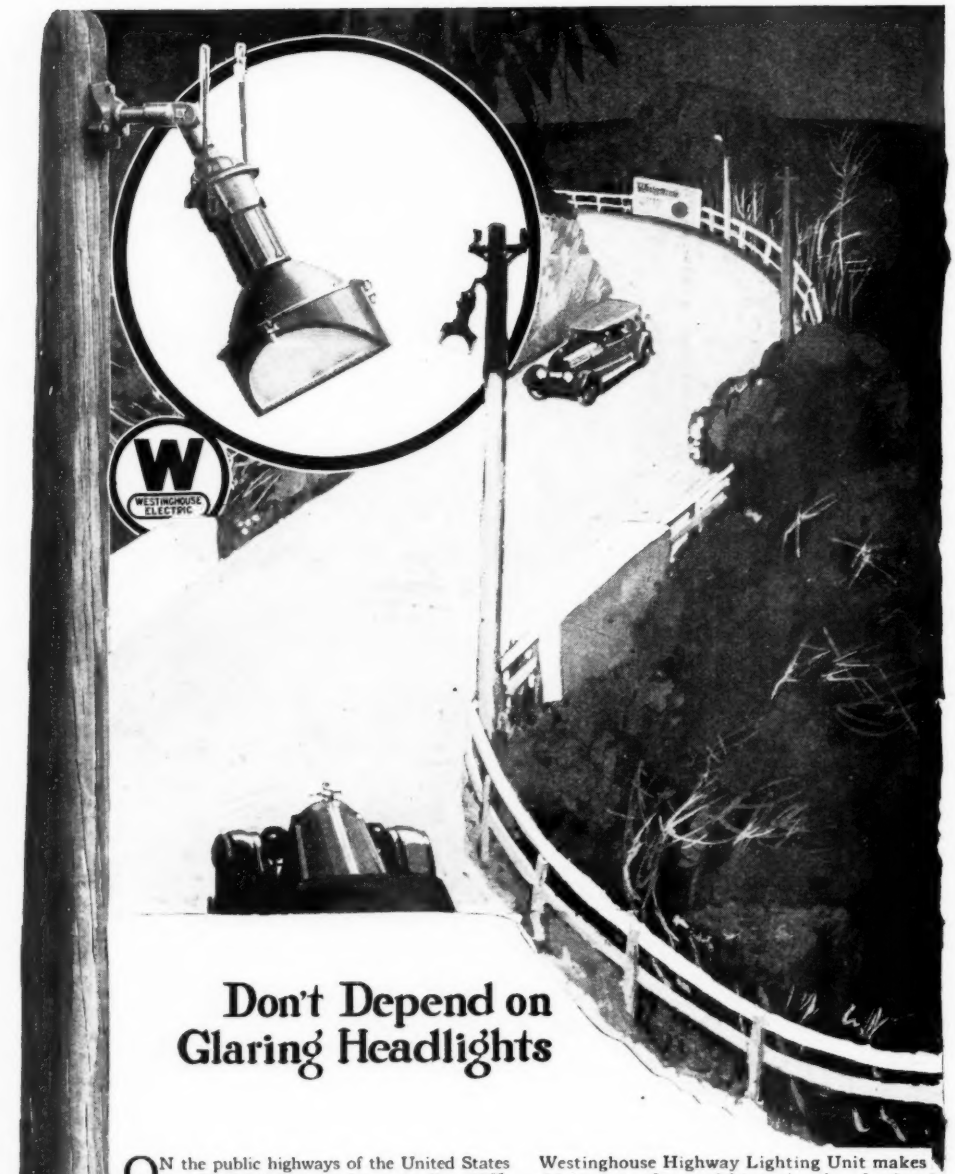

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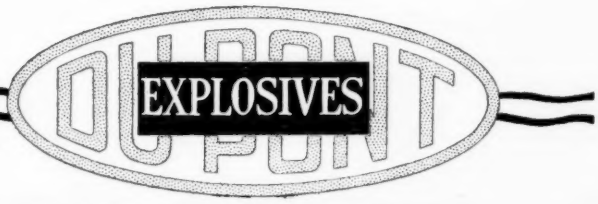

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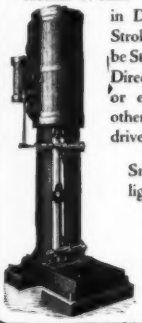

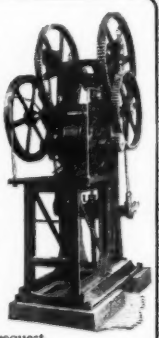

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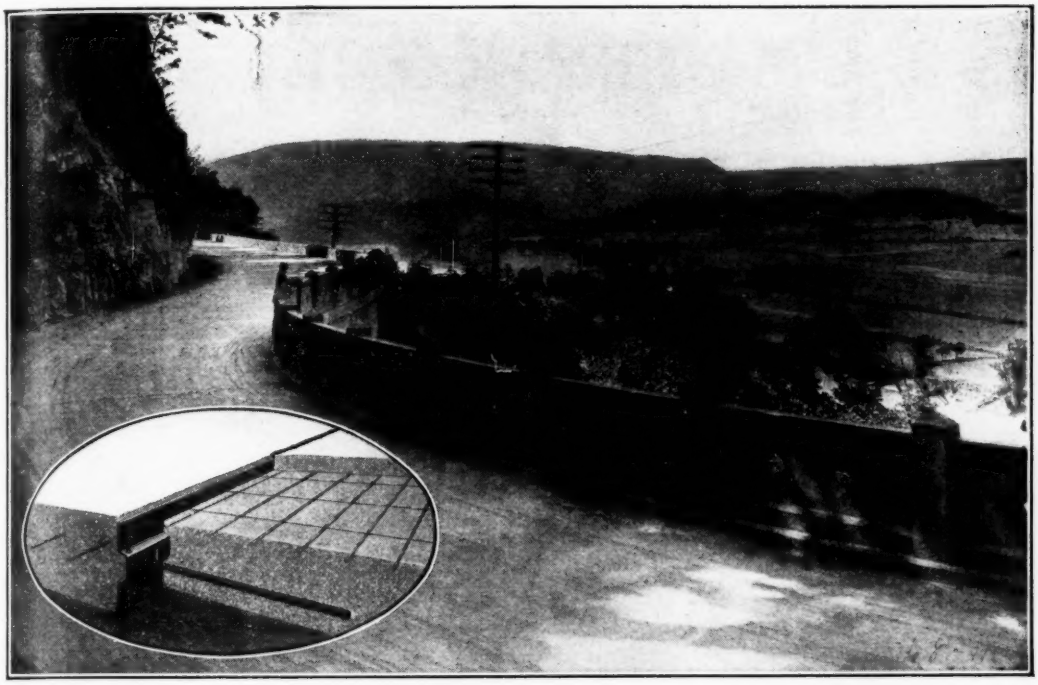

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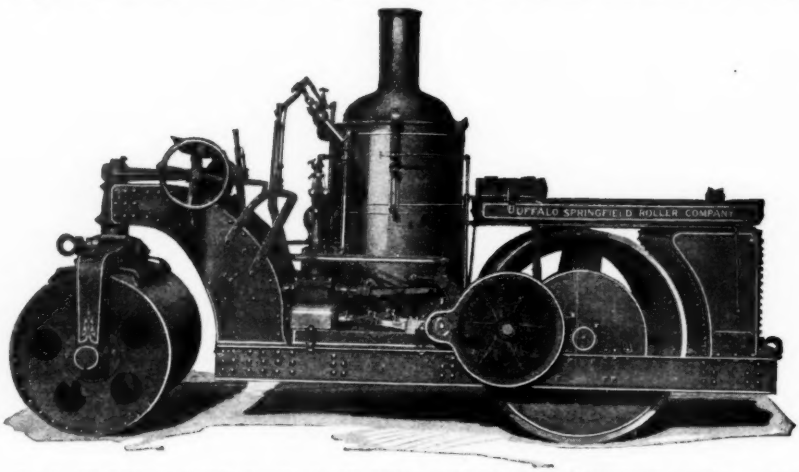

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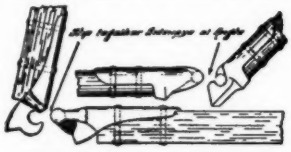

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EDITORIALS

OUR INCREASING HIGHWAY TRAFFIC

That traffic on our country highways is increasing everybody knows, but perhaps few realize that this traffic is increasing even faster than the registration of motor vehicles. That this is true was clearly shown by the Rhode Island traffic surveys in 1920 and 1923. Traffic over the Rhode Island State Highways was observed at 18 stations in 1920 and again at the same stations in 1923. During this period automobile registration had increased 41 per cent while traffic increased 87 per cent. The greater increase in traffic appears to indicate that motor vehicles are used much more than they were three years ago.

A good road is always an invitation to traffic. In fact, quality always increases use. A traffic survey made on a road before it is paved is likely to give a very inadequate idea of the traffic the road will carry after it is paved. Not only will people go out of their way to get on a paved road but paving enormously increases driving pleasure.

Where the volume of traffic is used as a guide to paving, therefore, it is well to pave when there is any doubt on this point. As soon as the road is paved and opened for public use it will carry an enormously increased traffic. That much of this increase is due to pleasure driving takes nothing from the soundness of investing in the pavement. If the American people want to drive for pleasure they have every right to do so and they have every right to provide the types of roadways that make driving a pleasure to be anticipated rather than an ordeal to be dreaded and borne with fortitude.

THE CITY REAL ESTATE AGENT

When a city embarks on an extensive program of public improvements, involving incidentally the acquisition of private property, much money can be saved the city by employing an honest and experienced real estate agent. It is a well-known fact that once the owner of a piece of property learns that the city wants it, he immediately demands a higher price for it than he ever dreamed of securing at ordinary sale. Of course this is not always the case. Some rich men and some comparatively poor men have been very generous in giving or selling property for public use, but it doesn't always work this way. Indeed, one grasping individual may nullify the generosity of a dozen unselfish men.

The best way to acquire property for public use is to send a salaried real estate expert after it. He knows its true value and can not be deceived, bluffed or otherwise imposed upon. This plan has been tried out successfully in Milwaukee, as described in an article published in this issue. It has resulted in enormous savings to that city.

PROFESSIONAL STATISTICS SHOW INCREASE OF ENGINEERS

The president of the Carnegie Foundation for the Advancement of Teaching recently compiled and promulgated some interesting statistics on various professions, including engineering. These figures show that in the past decade the number of physicians, lawyers and clergymen in the United States, in proportion to the total population, has decreased, while the number of dentists, trained nurses, welfare workers, "healers" and engineers has increased.

Figures for 1920 show 122,519 lawyers in this country, including judges and justices. There were 150,007 physicians and surgeons, including osteopaths; 127,270 clergymen and 64,660 civil engineers and surveyors. In the decade ending in 1920 there was an actual increase in the number of lawyers of 7,815, or 6.8 per cent; a decrease in physicians and surgeons of 1,125, or 7 per cent; an increase of civil engineers and surveyors of 12,627, or 24.3 per cent; electrical engineers, 11,799, or 77.2 per cent; mechanical engineers, 23,175, or 159.7 per cent, and a decrease of 235, or 3.4 per cent, for mining engineers.

The following figures give the number of members of these professions to each 100,000 of population in 1920: Physicians and surgeons, 142; clergymen, 120; lawyers, 116; civil engineers and surveyors, 61; mechanical engineers, 36; electrical engineers, 26; mining engineers, 6.

It is interesting to compare these figures with impressions based on general reading. The increase in electrical and

mechanical engineers is greater and the increase in civil engineers is less than we supposed. That overcrowding in the older professions is now a fact is the only conclusion to be drawn from the proportionate decrease among lawyers, doctors and clergymen. Unless many of the thousands of engineering graduates that are being turned out each year place themselves elsewhere than in engineering practice, the engineering profession must soon become seriously over-manned.

TRANSPORTATION COMPETITION, CO-OPERATION AND CO-ORDINATION

In this issue we devote considerable space to an article by Prof. Frank Haigh Dixon, of Princeton University, on "Co-operation vs. Competition in Transportation Service." This subject is important to all interested in the movement for improved highways and highway transportation, as there is much active opposition to the highway building program from those who feel that highway transportation bids fair to injure transportation service in general by taking so much business from the rail lines that they will be weakened so much their service will deteriorate. We have published Professor Dixon's article because we want to have both sides of this question properly before the readers of this magazine.

We believe it is useless to theorize about an idealistic state in transportation. No matter how desirable transportation co-operation and co-ordination may be, we think they will follow competition and that nothing else will bring them about. Our inference, years ago, that this would prove true, reasoning from our knowledge of the workings of the railroad mind, has been borne out in recent transportation history. For years rail men, representing the great trunk lines, have been saying the railroads lost money on short haul package freight and would much prefer to turn over this unprofitable business to the truck lines. But the railroads, in spite of their statements of this view, kept right on operating peddler freight trains in direct competition with the truck lines. Within very recent months the Pennsylvania and the New York Central have dropped a few of these trains and have turned this class of freight over to commercial haulers. This was done only after the trucks had secured most of the business anyway. Now our point is just this: These railroads would never have embraced co-operation and co-ordination if they had not lost the competitive fight. Had the truck men quit years, or even months, ago these railroads would not now be turning to motor transport. Competition is often the "daddy" of those heavenly twins—co-operation and co-ordination.

Just how far motor transport will go in superseding rail transport no one can say at this time. This is something that should be allowed to work itself out. If the "big idea" were merely to protect the money invested in rail lines, that could be done by curtailing highway development and by stopping all competition between the railways and motor trucks and buses. The trouble with this solution is that it ignores the public interest. The public interest will be best served by allowing unrestricted competition between the railways and the highways, at least for the present and the fairly near future.
be acquired in any other way.

One is always likely to reach faulty conclusions when he starts to compare two things which are so essentially dissimilar as railway and highway transportation. A conclusion based on competition between rail lines may be totally misleading when applied to competition between a railway and a highway. Many of our ideas on this subject have been set forth in these pages and will not be repeated at this time. It is well, however, to point out that the "common carrier motor vehicle" is a much misunderstood instrumentality as is the road it runs on. Commercial vehicle traffic is a by-product. Roads are not built primarily for the commercial vehicle but for the private passenger car. After these roads are built for the private passenger car the gain to the public from commercial vehicle operation is akin to the recovery of a valuable by-product in a manufacturing process which greatly increases the profits of the enterprise. If we deny to the people the right to use the commercial vehicle we withhold from them much of the profit they should realize from their investment in modern paved highways. To allow complete freedom of movement to the commercial vehicle "not for hire" while imposing heavy taxes or other restrictions on the commercial vehicle "for hire" is not in the public interest as this may mean a man can not ship by truck unless he becomes a truck owner and operates a private truck line.

ROUGHNESS AS A FACTOR IN PAVEMENT LIFE

By A. T. Goldbeck, Chief, Division of Tests, Bureau of Public Roads, Washington, D. C.

From the standpoint of the road user there can be no question of the desirability of as smooth a riding surface as can be produced. The instant a rough stretch of pavement is encountered the vehicle driver is made conscious of it by reason of rapid, unpleasant vertical motion which is imparted to the entire vehicle, a portion of which, at least, reaches the driver. He knows the exhausting effect on himself of a rough road in comparison with that of a smooth one. The vehicle owner also is quite conscious of the increased maintenance cost on his vehicle resulting from rough roads. But let us see what this means in terms of the life of the pavement itself.

Road Roughness

There are certain types of road roughness such as the inequalities in a concrete surface due to slightly projecting fine or coarse aggregate or by the brooming of the surface after finishing, the slight roughness of brick pavements due to the joints, and roughness of a similar kind in other types of roads, all of which are of little consequence in any of the ways in which road roughness might be a factor. Such slight inequalities are readily absorbed through the depression of the rubber tires and very little vertical motion is imparted by them to the vehicle. Such roughness can be forgotten as compared with other types of roughness which are really important.

Roughness in Concrete Roads

There seems to be little excuse for roughness in new concrete roads constructed with the most modern methods, and yet there are many roads which are not smooth riding through lack of attention to every detail. Roughness in a concrete road can very readily occur if the side forms are insufficiently supported, not sufficiently rugged, especially when a finishing machine is used, or when carelessly placed. Even with the smooth finish which can be accomplished both by hand and machine methods, a concrete road surface may still develop unevenness due to lack of homogeneity of the mixture or a non-uniform consistency, resulting in settlement of the concrete in some spots more than in others. The difficulty of maintaining a smooth surface in concrete laid on steep grades is also well known. Especially during cold weather, which interferes with the rapid setting, motion of the concrete is apt to take place on hills resulting in the formation of a series of waves. The difficulties of obtaining evenness at expansion joints have not in all cases been overcome. After several years of service additional inequalities might develop due to subgrade settlement, slipping at expansion joints or heaving, or to incipient blow-ups from temperature and moisture expansion.

Roughness in Bituminous and Other Types

The bituminous types are likewise difficult to finish with the desired degree of smoothness, and when the mixture or workmanship are not proper, waves develop under the combined action of traffic and warm weather. In addition, subgrade, settlement is more apt to produce inequalities in roads of the flexible type than in the rigid type.

The chatterbox surface which develops in gravel roads is well known, and its effect on both the driver and vehicle are quite apparent. Such waves seem to be caused by the combined action of the springs and the spinning of the wheels, and they increase very rapidly unless the surface is constantly maintained. Similarly, the other types of surfaces under the action of traffic and the expanding action of heat and moisture, both in the road surface and in the subgrade, in time develop roughnesses of different kinds and degrees even though they might have been reasonably smooth just after construction.

Effect of Road Roughness

Let it be assumed that a high joint has developed in a concrete road and that a motor vehicle is traveling in the direction from the high side of the joint. Figure 1 illustrates the motion taken by the hub of the wheel and by the body of the machine during the time of free fall of the wheels. When the vehicle is running at high speed, for an instant the tire will be out of contact with the road surface, but immediately the force of gravity and the force due to the compression of the truck spring shoot the unsprung weight of the vehicle downward with high velocity. The body of the machine falls downward very much more slowly since it is acted upon downward by the force of gravity alone and this is counteracted to some extent by the upward force of the springs. When the tire comes into contact with the surface, pressure on the road is developed

which increases rapidly as the tire is compressed and finally reaches a maximum value under the greatest flattening of the tire. The high vertical velocity of the wheel due to the kick of the spring and force of gravity is reduced to zero during the extremely short interval required to attain extreme compression of the tire. In other words, the unsprung

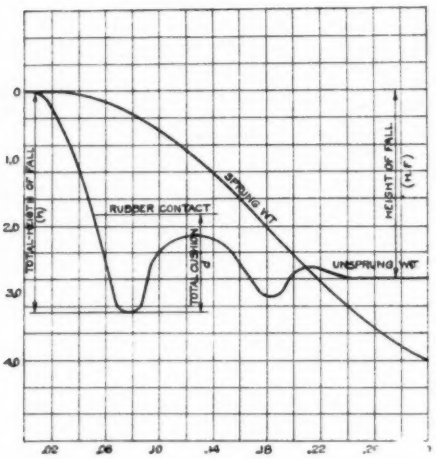


FIG. 1—MOTION OF HUB AND BODY DURING TIME OF FREE FALL OF WHEELS.

mass of the vehicle has been decelerated and the pressure between the tire and the road surface has increased from zero at the time of initial contact to a maximum at the time of full contact.

The maximum pressure created on the road surface is entirely dependent upon the deceleration or rate of change of vertical velocity, on the mass of the unsprung portion of the vehicle and on the spring pressure at the instant of maximum compression of the tire. This pressure may be calculated by the formula

$$F = M\ (a + g) + P$$

where M equals mass of unsprung portion carried on one wheel, a equals maximum vertical deceleration, g is the acceleration of gravity, and P the spring pressure at instant of full tire compression. From this formula it is quite evident that the pressure on the road surface is affected by both the sprung and unsprung weights of the vehicle, for M is a measure of the unsprung weight and P depends largely upon the sprung weight. It is likewise evident that the height of fall must increase the pressure on the road surface, since the higher the fall the greater will be the vertical velocity of the unsprung portion of the vehicle at the instant of tire contact. It is likewise evident that any condition which changes the quantity a will likewise greatly change the pressure created on the road. It is apparent that during the impact the pressure under steel tires must be greater than under solid rubber tires, and that solid rubber tires must create greater pressure than pneumatic tires, all other conditions being alike.

It is not necessary that sudden inequalities be present in a road surface to produce greatly increased pressure on that surface. Let us assume that a heavy vehicle is traveling at 20 miles per hour and that there is a rise in the road surface of ¼ in. in a distance of 1 ft. Let the unsprung portion of weight on one wheel be 3,000 lbs. and the sprung por-

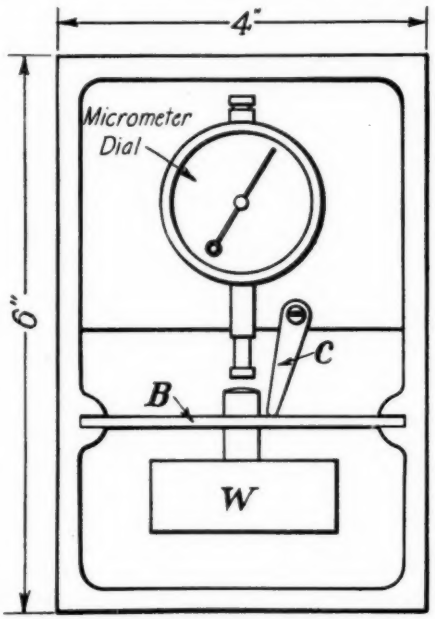


FIG. 2—DIAGRAM OF ACCELEROMETER FOR MEASURING IMPACT ON ACTUAL ROAD SURFACES.

tion 6,000 lbs. Omitting tire compression, the vertical acceleration of the unsprung portion equals approximately 37.5 ft. per second. The force on the road surface equals

$$\frac{3{,}000 \times (32.2 + 37.5) + 6{,}000}{32.2} = 12{,}480 \text{ lbs.}$$

as compared with 9,000 lbs. the static weight of the vehicle. This would be the force created if the tire were of steel instead of rubber. The effect of the rub-

ber is to decrease the vertical motion of the unsprung portion of the vehicle, thereby somewhat decreasing the pressure on the road surface.

It is likewise conceivable that a wave in a road surface will lead to impact when the speed is so high that the inclined approach of the wave shoots the wheel entirely free from the surface so that it lands with a free fall.

Measurement of Impact on Road Surfaces

In 1921 a large series of tests were completed by the Bureau of Public Roads in which it was demonstrated that rather high impact pressures were produced on the road surface under conditions of artificial roughness. (See March and December, 1921, issues of Public Roads.) These measurements were made by determining the pressures required permanently to deform a small copper cylinder placed under the plunger of a hydraulic jack buried under the road in a position to receive the impact of the motor vehicle. As a result of this series of tests, the following conclusions were as that time drawn:

Impact

Impact depends largely upon the kind and condition of the tire.

Thin or worn solid rubber tires, even though they be very wide, produce very high impact forces.

Pneumatic tires offer the greatest influence in reducing impact forces, and with their use the impact increases only very slightly with the speed of the truck.

Cushion tires, that is, tires having a degree of softness and deflection between solids and pneumatics, offer corresponding advantages in reducing impact.

Impact increases with the speed of the truck, but it can not be said to increase according to any constant ratio or power of the speed.

Although heavy unsprung weight may give higher impact than lighter unsprung weight, it can not be said that this is the major controlling factor.

The relative destructive effect produced by light-weight, high-speed trucks and heavy, slow-moving trucks has not been determined by these tests. They do, however, indicate that equal impact may be obtained under some conditions.

Impact may be as high as 7 times the static load on one rear wheel when a solid-tired truck strikes a 1-in. obstruction at 16 miles per hour, an average value being about 4 times. For pneumatic tires, the maximum impact value is probably not more than 1¾ times the load at one rear wheel, and an average value is not more than 1¼ times the load.

All cushion wheels do not reduce impact on the road surface even though they may cushion the vehicle.

The above tests, of course, were run with artificial obstructions and depressions in the road surface, and the question naturally arises: Are actual road surfaces likely to produce any such impacts as indicated by the above series? To answer this question, impacts have been measured by the use of an accelerometer mounted on the rear axle in a position to measure the vertical deceleration of the unsprung portion of the vehicle in striking the road surface. The path taken by the hub of a motor truck wheel in striking the surface and the manner of calculation of the impact pressure has already been indicated. The accelerometer used is shown diagrammatically in Figure 2. The weight W deflects the spring B, and the stop C holds the spring in its position of maximum deflection. The amount of deflection is read by means of the dial. The more suddenly the wheel is brought to rest vertically; in other words, the higher the deceleration, the more will the spring deflect when the instrument is mounted on the unsprung portion of the vehicle. The actual instrument used was designed on the above principles.

Actual Road Tests of Impact

Tests were made by running different sizes of motor trucks over typical concrete roads and noting the maximum reading of the accelerometer. Knowing the unsprung and sprung weights of the vehicle and knowing the acceleration as determined from the accelerometer, the impact pressures were then calculated and it has been found that on typical concrete roads which have been in service up to four or five years, considerable impact pressure can be developed. Tentatively, it can be stated that the maximum pressures to be expected under the rear wheels of the motor trucks are as follows:

2-ton, 18,000 lbs.
3-ton, 24,000 lbs.
5-ton, 30,000 lbs.

Additional tests are now under way which will throw more light on the accuracy of these figures. These pressures correspond reasonably well with the pressures found by the use of the copper cylinder measurements already men-

tioned and correspond to heights of fall of the rear wheels well up to 2 ins. as determined in the old copper cylinder tests.

For calibrating the accelerometer used in these determinations, one of the means employed was the so-called Kreüger cell. A spherical-ended plunger of exceedingly hard steel bears on a flat-ended anvil which is smoked with lamp-black. If impact is delivered on this cell the spherical and flat surfaces are deformed, thereby producing a circular mark on the lamp black coated surface. The diameter of this mark depends upon the pressure which has been produced and this may be determined by calibrating the instrument in a testing machine. Simultaneous readings of the accelerometer mounted on a motor truck and the Kreüger cell to which impact is delivered by the motor truck serve as an excellent check on the accelerometer method of measuring impact.

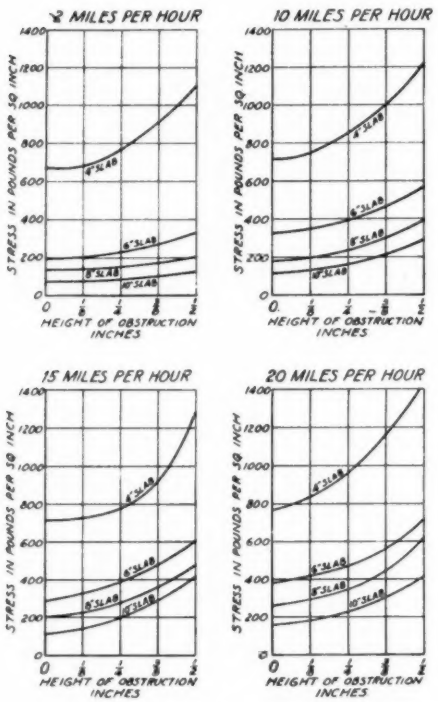
The Effect of Impact on the Stress in Concrete Roads

It would seem to follow that the higher the pressure created on a road surface, the higher should be the stresses created within the surface and, in general, the more rapid should be the deterioration of the surface. Road materials differ very widely in their characteristics. Thus, concrete is perhaps the most elastic of the road surfaces in the sense that definite deformations are to be expected with definite increase in load. The bituminous surfaces behave more like plastic material, the degree of plasticity changing with the temperature. Macadam, gravel and sand-clay follow the laws which govern masses of granular materials and they possess elasticity and plasticity to a very limited degree.

The nature of the effect of the impact of traffic produced by roughness in these different surfaces will therefore be different, depending upon the type of surface. Since concrete is of an elastic nature it offers the possibility of making accurate measurements of stresses produced by traffic forces and the relative stress effect produced by different degrees of roughness can therefore be very accurately determined in a concrete road, and the stress produced furnishes a measure of the degree of destruction likely to result in the road surface.

Measurement of Fiber Stresses in Concrete Roads Produced by Impact of Motor Trucks

For measuring the stress or deformation in the road surface recording strain gauges were set along the edge and as close to the bottom of the slab as possible. Similar instruments were placed at the edges of pavement slabs 4, 6, 8 and 10 ins. in thickness, built for test purposes on several kinds of subgrade. A motor truck equipped with solid tires was then run at speeds of 2, 10, 15 and 20 miles per hour with the center of the rear wheels 9 ins. from the edges of the road. Over each position of the strain



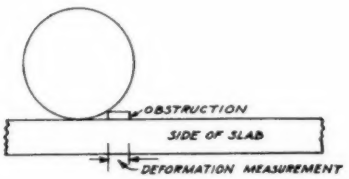


FIG. 3—VARIATION OF STRESS WITH ROUGHNESS.
(Hard Subgrade, 5,000-lb. Wheel Load, Solid Tires).

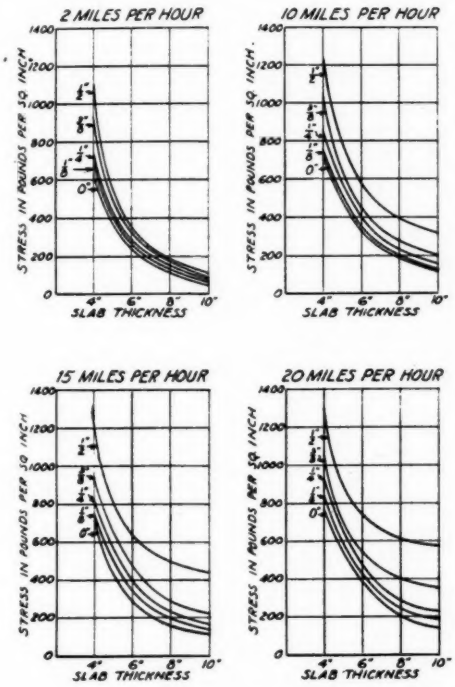
gauge an obstruction was placed on the road, consisting of a metal plate 3 ins. in width with thicknesses of ⅛, ¼, ⅜ and ½ in. for the different conditions of operation of the motor truck. As a result of these tests the stresses shown in Figures 3, 4 and 5 were obtained.

Referring first to Figure 3, Variation of Stress with Roughness, it is to be noted that for a given speed the stress always increases as the obstruction increases in height and, as might be expected, the effect is much more severe on the thinnest slabs. It is evident that the fiber deformations may be at least doubled when an obstruction of ½ in. occurs in a concrete road and the truck is caused to mount over that obstruction. Any condition which would make the truck wheel fall through the same distance would give very similar results.

In Figure 4 is shown the variation of stress with the thickness of the slab when those slabs have varying degrees of roughness, and in Figure 5 is shown the variation of the stress with the speed of the vehicle. Apparently, for small roughnesses up to say ¼ in., the increase in stress with speeds up to 15 miles per hour is quite small with all the thicknesses of slabs, but when the speed becomes higher than this the stress curves show a rapid increase in stress as the speed increases. The ½-in. obstruction, even at low speeds, produces a very much higher stress than found in the smooth slab, and moreover the stress increases very rapidly with the speed.

In calculating stress it has been assumed that the modulus of elasticity of the concrete was 3,000,000 as determined in a static load test. It will be noted that the stresses obtained in this way in many cases exceed 700 or 800 lbs. per sq. in., the probable modulus of rupture of the concrete. The fact that no cracks are apparent in spite of this high stress needs more investigation to arrive at a satisfactory explanation.

According to investigations on the fatigue of concrete made at the Illinois State Highway Department laboratory, it seems that under repeated loads failure takes place under a comparatively few applications of loads producing a stress in excess of 50 per cent of the modulus of rupture. In the absence of more exact information on the relative stress at failure under impact and static loads, it would seem safest to accept half of the modulus of rupture as the safe unit stress produced dynamically as well as statically. If 800 lbs. per sq. in. is the modulus of rupture of the concrete, the safe unit stress would then be 400 lbs. per sq. in., and it will be seen that the 5,000-lb. wheel load stressed the 4-in. slab beyond safe limits even when no artificial impact was produced. The 6-in. slab became unsafe with a ⅛-in. roughness at 20 miles per hour and with a ¼-in. roughness at 10 miles per hour. The 8-in. slab began to receive an unsafe stress at 20 miles per hour with a ⅜-in. obstruction, and with a ½-in. ob-



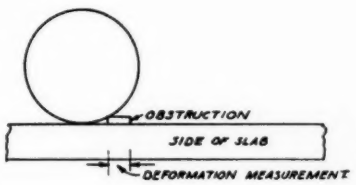


FIG. 4—VARIATION OF STRESS WITH THICKNESS.
(Hard Subgrade, 5,000-lb. Wheel Load, Solid Tires).

struction at 10 miles per hour. The 10-in. slab was not over-stressed with a ⅜-in. obstruction at 20 miles per hour, but with a ½-in. obstruction was over-stressed at about 13 miles per hour. It is thus apparent that the deteriorating effect of roughness is different, depending upon the thickness of the slab.

Effect of Roughness on Bituminous Pavements

The effect of roughness on the deterioration of pavements of the bituminous type is a matter of common observation. Everyone has observed the depressions formed in the best types of asphalt pavements on the far side of manhole covers in city streets. The slight impact of traffic results in the production of impact pressure which the pavement can not resist in its most plastic condition. Depressions in asphalt pavements resulting from any cause, whether from a local settlement, improper mixture or rolling, lead to impact with a resulting increasing roughness of the pavement and deterioration whose progress will be rapid under heavy wheel loads and high temperatures.

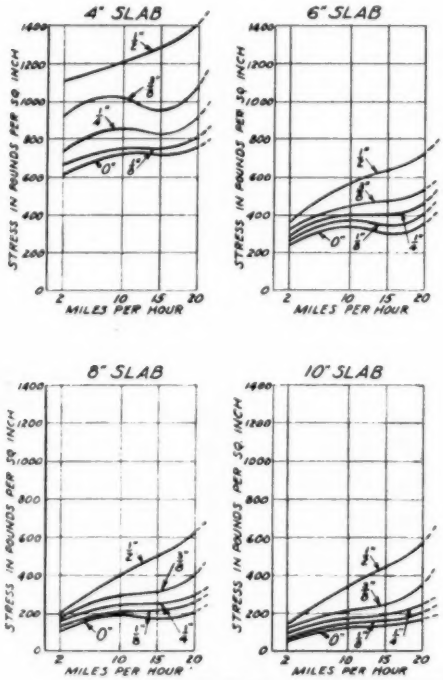
Washboard Effects in Gravel Roads

The growth of washboard effects in gravel roads is known to be very rapid after a slight roughness once forms, and this growth may proceed from the formation of a single low spot which produces a succession of impacts of the vehicle wheels. Under average speed conditions the wheels land at approximately the same spots in the road, and on landing, the spinning wheels displace some of the road surfacing material, thus forming the waves with crests of loosely compacted gravel and troughs with material in a well compacted condition. The higher the waves, the harder the impact becomes, and the faster the surface deteriorates. All of the evidence then points to the desirability of not only producing a smooth surface initially but by maintenance measures keeping that surface in as smooth a condition as possible.

Devices for Measuring the Roughness of Roads

Within the past few years several devices have been proposed for obtaining a measure of the roughness of roads. One of these devices developed by the Bureau of Public Roads and assembled by the Illinois State Highway Department is shown in Figure 6. It consists of a frame which may be set up on the road surface in the position desired and which then serves as a smooth trackway over which is run an auxiliary truck upon which is mounted an autographic device for recording the movement of a tracer wheel bearing on the road surface. The tracer wheel is drawn from one end of the frame to the other. The frame is then transferred to another position and the record thus obtained. This device was used on the Bates experimental road.

A similar device using the same kind of autographic recorder has been used in experiments conducted by the Iowa



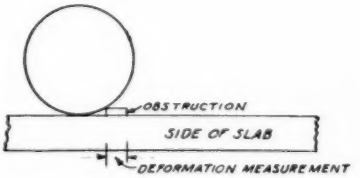


FIG. 5—VARIATION OF STRESS WITH SPEED
(Hard Subgrade, 5,000-lb. Wheel Load, Solid Tires).

State Highway Department. Both of the above devices record the absolute roughness of the road. Still another device used by the Bureau of Public Roads is shown in Figure 7. It is mounted on a frame connected with the axle of a motor truck. A weight suspended between an upper and lower spring serves to produce vertical motion of the recording pen as the entire apparatus follows the vertical motion of the axle of the vehicle. The recording drum is moved by means of the speedometer cable. This same type of recording apparatus may also be mounted in the body of the vehicle and the vertical motion of the axle with respect to the body is then readily transferred to the recording apparatus. This device may also be fitted with an auxiliary attachment for accumulating the vertical motion of the axle. When this device is used it is necessary, of course, that the vehicle be run at a constant speed and that the tires and springs be kept under uniform conditions. The record obtained does not give an absolute measure of the roughness but it does give a relative measure of the roughness and the record of the vertical motion accumulating attachment gives an index figure which is indicative of the relative roughness of the various types of roads. Such a device was built by the Bureau of Public Roads several years ago and has since independently been made available in commercial form. Still other devices for determining the roughness of roads can be developed and may be used for rapidly determining the profile of the finished road.

In Figure 8 are shown typical records obtained with the instrument shown in Figure 7. A 5-ton truck equipped with new solid tires was used in the test runs. A profile of the road obtained by precise levels at 6-in. intervals is plotted at the bottom. Each peak in the records

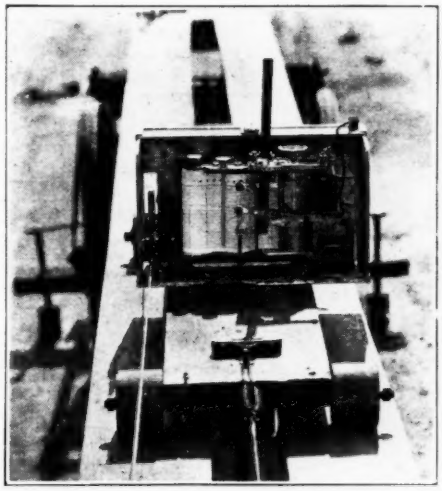


FIG. 7—RECORDING ACCELEROMETER.

indicates an impact due to roughness and the higher the peak the greater has been the blow struck by the truck wheel. In general, note that—

1. Even a seemingly smooth road surface will have appreciable roughness.
2. The higher the speed, the greater and the more frequent will be the impacts delivered to the surface by the trucks.
3. The rougher the road, the greater are the impacts as shown by the increased height of peaks with ⅛-in. and ¼-in. obstructions.

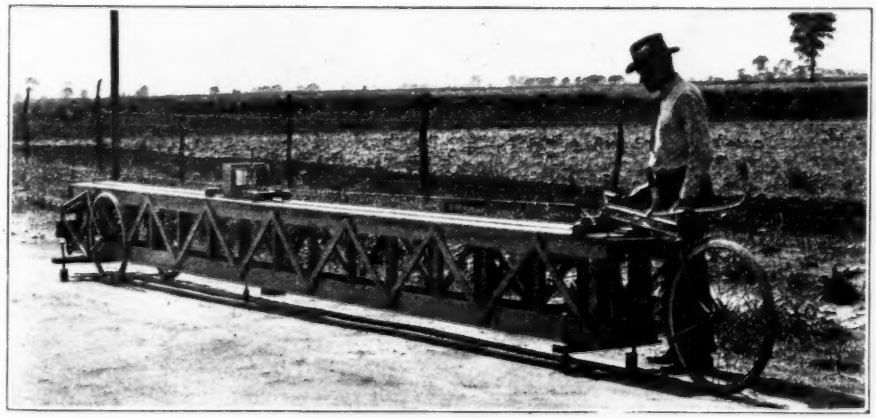


FIG. 6—PROFILOMETER USED ON BATES ROAD.

It is possible to specify the degree of roughness and it is believed that it will be highly desirable that road specifications have incorporated in them provisions for the maximum roughness per-

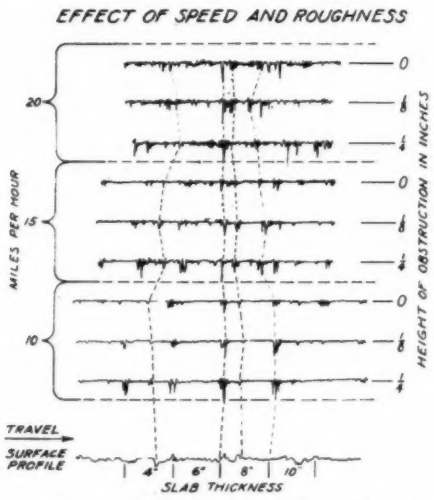


FIG. 8—RECORD SHOWING EFFECT OF SPEED AND ROUGHNESS.

missible and encouragement should be lent to the development of every possible means for attaining and preserving as smooth a highway surface as practicable.

The foregoing paper by Mr. Goldbeck was presented at the 1924 meeting of the American Road Builders' Association.

COOPERATION VS. COMPETITION IN TRANSPORTATION SERVICE

By Frank Haigh Dixon, Professor of Economics, Princeton University, Princeton, N. J., and Lecturer for National Transportation Institute.

In the discussion of the topic assigned to me, "Cooperation vs. Competition in Transportation Service," I can impose upon you my own view of this antithesis with far more confidence that I shall have a favorable hearing than might have been the case a decade or two ago. We are approaching the time in the relation of our transportation facilities to our economic life when the larger part of the thinking public is about ready to concede that co-operation among our transportation agencies is not only essential but imperative.

The Doctrine of Competition

This has not always been the dominant belief—in fact this conviction as a popular possession is rather new. And it is not strange that it should be so. We have been educated from the beginning of our transportation history to a comfortable reliance upon the doctrine of competition. Paralleling railway lines have been chartered and subsidized and nursed as the only apparent means of protecting the public against extortionate rates. Millions of dollars have been spent in improving waterways with the hope—largely unrealized—that traffic could be attracted to this supposedly cheaper agency of transport. Or, if this hope proved false, the waterway in any case could stand as a threat against the approach of railway monopoly.

Every attempt upon the part of railways to escape the inevitably disastrous consequences of competition among themselves, such as the organization of gentlemen's agreements, pools and traffic associations, have been met with indignant protests by the public, and statutes have been passed specifically directed to the prevention of any co-operative arrangement whatever. We announced that if railways were so obstinate that they persisted in not competing we would make them compete by law.

It was an attitude that still prevails in much of our legislation relating to large business. We have the Anti-pooling Clause of the Interstate Commerce Act of 1887, the Sherman Anti-Trust Act of 1890, which was at once made applicable to the railways, the Clayton Act of 1914, with its prohibition of intercorporate and interlocking relationships. A recent letter of former Attorney General Dougherty to Secretary Hoover discussing the problem of the open-price association declares that such organizations are presumably illegal because a benevolent attitude of one member toward another is inconsistent with real competition. All of these reveal the innate public dread of monopoly, and a childlike reliance upon competition as a protection against extortion.

Returning to Highways

Finally, beginning with the war, we experienced a sudden return to the use of the highways for long distance transportation and the rapid development of motor truck service, with all its problems. And in the face of what our experience should have taught us as to the wastefulness and futility of competition among transportation enterprises as a regulator of charges and a guardian of the public welfare, this new agency was

eagerly seized up on by shippers as a means of clubbing the railways into submission. So enthusiastic did we become in many sections of the country over this alternative method of transport that we spent our money recklessly to smooth its path, we showered it with favors and we asked for almost nothing in return.

This brings us down almost to the present moment and yet I still feel justified in expressing my belief that there is a large and a growing sentiment abroad not only for a greater degree of cooperation among the various necessary transportation agencies, but more specifically for some sort of comprehensive, nationwide plan which as a result of study and experimentation will discover the exact place that each form of transport may justifiably occupy in our economic system, a plan that will not necessarily eliminate all competition between different agencies but will recognize that competition is not the universal panacea that we have commonly assumed, and that it must be checked and modified and adjusted in such fashion as to give to the public the best that each agency of transportation can contribute.

The Regulated Monopoly

In place of the policy of unrestrained competition which has dominated our transportation development almost to the present moment, in which the consuming public was assumed to be protected in the price it pays for transportation by the rivalry of the various agencies for its patronage, we are gradually introducing that of regulated monopoly, in which competition is to a degree restrained and the public interest is guarded against combination and extortion, by administrative agencies created by law and endowed with regulatory powers over transportation rates and practices. This system as an efficient agency of control can be said to be hardly more than a decade and a half old, although we have been experimenting with the so-called commission plan in the jurisdiction of state affairs for fully fifty years and in the federal jurisdiction for nearly forty.

But these earlier years of experimentation while providing a splendid training school for future regulating agencies and furnishing much useful experience to the pioneers in the movement for administrative regulation, accomplished little of enduring value because of the inadequacy of the statutes under which the commissions operated. Not until 1910 was regulation looked upon with any degree of respect by the corporations regulated.

The Transportation Act of 1920

That the era of unrestrained competition is passing is nowhere more significantly revealed than in the Transportation Act of 1920, the latest expression of popular opinion in the field of federal regulation. Opportunity does not permit any detailed analysis of this statute, but I wish to direct your attention to a few significant clauses that point the way in which public policy seems to be moving.

It has been provided that no new railroad construction shall be undertaken without a certificate from the Interstate Commerce Commission that the present or future public convenience and necessity require it. Such a provision has been present in the laws of some of the states for many years, but this is its first appearance in a federal statute. Its purpose as stated on the floor of the Senate when the bill was under discussion, was "to recognize as the controlling consideration the right and interest of the public to have reasonable and adequate transportation facilities and to escape payment for transportation facilities that are not needed and are mere duplications of existing facilities." How different in conception from the attitude of earlier legislators who made it their business to promote duplications of facilities and insisted upon them as the only means by which the public could escape the burdens of monopoly!

Joint Terminals

Again, the Commission has been given power to require that a carrier shall share its terminal facilities with other carriers, including the main track for a reasonable distance outside, and also the power to fix the compensation to be paid therefor. The wastes involved in the present system, or lack of system, of railway terminal administration is becoming a popular subject of discussion. The experiment with joint terminals during Federal control was sufficiently successful to raise the question of the desirability of its continuance. In fact some of the arrangements then made, such as the sharing of the Pennsylvania terminal in New York with the Baltimore and Ohio and the Lehigh Valley, have continued beyond the period of federal operation. The elaborate plans of the Port Authority for the development of terminal facilities in New York harbor are based upon the principle of joint use, and are directed by the purpose of assur-

ing to every shipper access to the terminal of every line of railway. We are necessarily moving slowly in this phase of cooperation because of the enormous property interests involved and because a too rapid approach to what might be an ideal condition woudl sacrifice seriously many long-established and wholly legitimate private rights. But the trend of the movement is unmistakable.

Chicago Experiences

The contrast between the new conception of railway terminal service and the old is most strikingly illustrated in the City of Chicago. This city, together with its railways, has already spent millions of dollars in reconstructing its terminal facilities and a beginning has scarcely been made. Elaborate studies have been undertaken by engineering and operating experts with the aim of arriving at some comprehensive plan that will adequately treat Chicago's traffic problem as a whole. It is a far cry from this situation to the Chicago of 1850, when the people were rousing themselves to a high pitch of indignation because the Michigan Central appeared likely to come into Chicago over the Illinois Central tracks and would not have its own right of way and its own station. To the loud and insistent demands in 1850 of teamsters and hackdrivers and real estate dealers and local shopkeepers, the newly rising city yielded only to discover as a result of its amazing development that in its eagerness for competition it had constructed a Frankenstein that was threatening to crush out its circulating system by the simple process of giving it too much to do. Traffic has become more than the streets can bear. It is a fair guess that if Chicago could start again with her present experience to guide her, she would adopt a radically different policy.

Taking National View of Rail Problem

It is necessary only to mention in passing as evidence of the changing spirit, the rate section of the statute of 1920, concerning which there has been so much discussion. Congress looks upon the railway system for the first time from a national viewpoint. It declares that the public must have assured service and it provides a system of rate-making which is designed to attract the capital necessary to develop this service. It provides for railway grouping, for determining the adequacy of earnings on a group basis. It provides for the recapture by the Government of earnings in excess of what Congress decides to be a fair return to the carrier. All this legislation is a violent break with our traditions and our former attitude of mind. The railway corporation is no longer a business entity living unto itself alone. It is a mere link in a nation-wide system, and it becomes by the nature of this new legislation a partner in a huge enterprise. It must cooperate whether it will or no.

And then still more emphatically is the way indicated by the consolidation provisions. To be sure, they are at present only in the form of a plan. No compulsion is placed upon the railways to unite themselves with others to form systems. But when we think back only two decades to the time when the combination of the Great Northern and Northern Pacific, effected through the Northern Securities Company, was dissolved by the Supreme Court as a restraint of trade under the Sherman Act, and how that decision met with wide popular endorsement, we realize what a turn-about face we are executing in waiving aside the Sherman Act, offering a plan of consolidation of nation-wide extent, and while retaining in many respects the competitive principle, extending to a degree never heretofore contemplated the principle of cooperation between former rivals.

Supreme Court Decisions

As a striking endorsement of the legislative policy embodied in the Transportation Act, we have three recent decisions of the Supreme Court, all of which are based upon the fundamental principle that transportation is an essential of national well-being to which the railways must contribute according to their ability, a partnership enterprise of a cooperative character rather than a struggle of selfish interests seeking individual dominance. There was first the Wisconsin Rate Case, in which the Supreme Court sustained the power granted to the Commission to raise rates on intrastate commerce to bring them to a reasonable basis of equality with interstate rates. The welfare of the nation as a whole displaces that of the individual state. The second case was the New England Division Case in which the power of the Commission was sustained to divide the proceeds of a through rate not alone upon the basis of mileage, but also with reference to the public importance of the transportation service involved. In other words, it may take from the strong roads and give to the weak, in order that all may survive. Finally there is the recent decision of the Court sus-

taining the recapture provision of the Act, a provision which in express terms recognized that a carrier that earned in excess of a certain prescribed rate upon its property was holding this excess as a trustee for the United States. The principle of cooperation could not have been clothed in more emphatic terms.

Water and Rail Transportation

I desire to make a final reference to the Act of 1920 and to discuss the relationship developed in that statute between water and rail transportation. If I seem to go into the matter somewhat fully, it is because the experience gathered from the history of this relationship has a helpful bearing upon the problems with which this conference is primarily concerned.

In the first place, Congress declared its policy to be that of promoting and developing water transportation and of fostering and preserving it in full vigor side by side with that of rail. While this declaration might at first reading appear to be merely empty words designed to satisfy an insistent lobby, it has as a matter of fact had a genuinely constructive influence. The Interstate Commerce Commission has interpreted it as a mandate, and has modified its decisions in conformity with this legislative expression.

In a more technical way, in the so-called long and short haul clause, it was provided that the Commission in exercising the power that it had long possessed to authorize a rate to the distant competitive point lower than to the intermediate point, might not grant such an authorization when water competition was merely potential or when the rate to the competitive point was not reasonably compensatory for the service performed. We are not here concerned with the interpretation of this complicated situation. The Commission has struggled with it in several decisions and no clear cut policy concerning competitive rail rates seems yet to have emerged. We are concerned rather with the Congressional attitude. What had Congress in mind in enacting these clauses? Clearly it intended that both agencies of transportation should be available to the public, that no restraints should be put on the one or the other that would interfere with its operation "in full vigor." And yet it is obvious that Congress did not expect this to be accomplished through the working of unrestrained competition. Railways may not anticipate water competition by cutting their long distance rates when the competition is only potential. Neither may they carry their competition to the point of pushing their competitive rates below what is reasonably compensatory for the service. It is clear that the solution must be found in some sort of cooperation between the two agencies—voluntary, if possible, otherwise compelled.

Effects of Panama Canal

Let us briefly summarize this transcontinental situation. The extraordinary growth of coastwise traffic through the Canal during the last few years has created a very serious situation for the transcontinental carriers, and the situation has been aggravated by the fact that for a time at least a large part of the shipping which was competing with the railways was being operated by the U. S. Shipping Board, with which the question of profit was not a significant issue. Uncle Sam could be counted upon to put his hand in his pocket if all other resources failed.

The transcontinental carriers are essential to their territory and hence must be assured earnings adequate to maintain their credit and secured the capital necessary for development. Water rates from coast to coast are such that even when marine insurance and other costs are added, the railways must, with respect to certain traffic, reduce their terminal rates below the existing standard if they are to share in this business. The railways insist that to be required to reduce correspondingly all intermediate rates would be disastrous to their revenues. Shippers at intermediate points argue that they should not be burdened with the costs of this competition which the roads are carrying on at the termini, an argument that rests on false reasoning where the terminal business contributes anything at all above the out-of-pocket costs of performing it. Of course, if the business cannot be obtained by the railway at the price that will pay the costs of performing it and something besides the railway should not be permitted to bid for it. Again, shippers at intermediate points argue—and with much more force—that nearer-by places cannot equitably be made to pay a higher relative charge for a shorter railway haul.

Control of Water Rates

Now here, it seems to me, is the opportunity for a careful survey as a basis

for a comprehensive, statesmanlike policy of cooperation. I am not sure that it will not lead to the necessity for the regulation of water rates by the Commission. But it should at any rate lead to a scientific allocation of traffic between the two agencies in such wise that both may be soundly managed and maintained. Certain traffic obviously should go by water. The public is entitled to the benefits of the Canal which it has constructed and the railways east and west must derive their earnings from this traffic through distribution between coast points and the interior. No discrimination against interior points and in favor of terminal points should in such traffic be permitted. Again there is traffic which will never go by water. This offers no problem. The distance principle of rate making would apply.

Finally there is the group of traffic in which competition, if permitted, will continue in vigorous fashion. And it is in this class of traffic that adjustments will be most difficult. The long and short haul clause must needs be suspended but terminal rates should not be lowered to the extent that intermed'ate traffic would have to carry the burden of the competitive struggle. In the end there would be worked out a realignment of function and redistribution of service to the mutual benefit of public and carriers—not a hard and fast system which would inevitably break to pieces, but an elastic plan subject to the modifications that a constantly varying traffic situation would require.

Co-operation in Water and Rail Transport

An instance of the development of the principle of cooperation between water and rail services which may in the long run furnish a guide to the inauguration of other experiments of a similar nature is provided by the present negotiations between the Mississippi-Warrior Service and the railways for the establishment of through rates. This barge service between St. Louis and New Orleans on the one hand, and between the coal fields of northern Alabama and New Orleans on the other was instituted in 1917 by private commercial interests, was taken over by the Government as a war measure, and has been owned and operated by the Govenment since—not as a permanent undertaking but to test the possibilities of this type of transportation service. Just a year ago the Interstate Commerce Commission rendered an elaborate opinion laying down the lines along which the railways and the barge line should proceed in drawing up an agreement for through routes and joint rates. And such agreements have in large part been consummated during the year 1923. While this waterway experiment has been hampered by lack of facilities, especially terminals, by inadequate appropriations and particularly by its inability, due to the method of government appropriations, to inaugurate a policy of operation along sound business lines, nevertheless the experiment is worthy of attention as a serious effort to make cooperative use of our rail and inland waterway facilities.

Highway Transport

I turn now, finally, to a brief consideration of the problem of highway transport. I have gone into this matter of transcontinental traffic somewhat in detail because there has been in process in that section the solution of a problem which in principle is not different from that which underlies the competition of railway and highway. What I have to say concerning highways must be of a general nature and confined to the limits of my topic of cooperation. Any attempt to enter upon a detailed discussion of the specific proposals for motor truck use would carry me far beyond my time limit.

My thesis is a very simple one. The highway policy which has been dominant throughout our history should be continued. Highways should be constructed and maintained at public expense so far as they are designed for the general use of the public, whether for pleasure or for commercial purposes. The proper method of distribution of this burden of expense through taxation so far as it has to do with provision of a highway for general public use is one that need not detain us here.

The Common Carrier

There should, however, be a sharp differentiation between the vehicle privately owned and operated and the common carrier. The motor truck setting itself up as a common carrier should be subject to all the obligations and the responsibilities which the common carrier is expected in this day to assume. It should be required to secure a certificate of public convenience and necessity, and once having undertaken its functions, it should be required to perform regular and continuous service. Its rates and practices should be subject to control by a public regulating body. Its taxes should be so adjusted that it contributes its share to the construction and maintenance of the high-

way that it uses. It may be replied that it is a matter of indifference to the public whether it pays for highway maintenance through taxes or through transport charges imposed by the carrier. But a little consideration will make it clear that a much more equitable distribution of the burden is possible if the carrier is taxed and includes this tax in the transportation rate. The user of the common carrier, rather than the public in general, thus pays the tax. Moreover, this higher transportation charge which the motor truck would now be compelled to impose in order to cover its tax burden, places this transportation agency in a fairer relation to its competitors. In attempting a solution of the problem of an equitable allocation of traffic between highway and railway, the task would be much simplified if highway carriers were contributing their share to the maintenance of their rights of way. We should be dealing more nearly with equals. Under such circumstances justice is more likely to emerge.

Proper Fields for Motor Transport

It is not my purpose here to discuss the proper role of the motor truck. That it has been recklessly and wastefully employed during these years of its jubilant development no one can well deny. And many of the companies that began with such promise to take long distance traffic away from the steam carriers at rates which the railways could not meet are now running head on to the rocks of depreciation and obsolescence. Such service which vanishes as suddenly as it comes and leaves behind it broken-down roads and a dissatisfied public can serve no useful public purpose. There are fields in which the motor truck appears to offer service superior to that of any other existing agency—for example, the service in connection with terminals and with store-door delivery. There are other fields, such as branch line and short distance local service, in which experiments with highway transport are now being conducted. It may be sound policy in many such instances to turn this service over altogether to the motor truck. And then, there is the longer distance traffic, much exploited by the motor truck interests, which can rarely be justified on sound business principles. The problem must be looked at in the large and it must be surveyed scientifically, perhaps experimentally, with the purpose of confining each form of service to that function for which it is best adapted.

Co-operation Between Rail Lines and Highways

It is most gratifying to find this position taken by the special Committee of the U. S. Chamber of Commerce on the Relation of Highways and Motor Transport to other Transportation Agencies—a Committee which had for its chairman a vice-president of one of the leading motor manufacturing corporations, and which included in its membership three other representatives of the truckage interests.

I may very properly close this brief discussion of the problem by quoting what this Committee had to say upon the subject of cooperation:

"It is to the public interest, as well as to the interest of the respective carriers, that the economic limitations of each type of carrier be recognized, that the railroads be permitted to discontinue unprofitable service to which the motor is better suited, and that the motor abandon its efforts to handle general traffic over excessive distances. However, because of the public interest which affects the operation of railroads, they have performed and must continue to perform some service which is unprofitable, chiefly in territory where the performance of highway transportation would also be unprofitable. If the railroads are to be deprived of a substantial share of their more remunerative traffic through unfair and, to the trader, uneconomical methods, the traffic remaining to the railroads must take on an added burden in the form of higher rates or impaired service. In all cases where the railroad can handle traffic with greater or equal efficiency, all factors being considered, the public interest requires that it be allowed to do so. . . .

"Investigations now under way by the U. S. Bureau of Public Roads, state highway departments and other agencies to determine more fully the economic role of the motor vehicle should be continued.

"The best interests of the public and the rail, water and motor carriers lie in cooperation between the various agencies of transportation rather than in wasteful competition."

The foregoing paper by Prof. Dixon was presented at the Tenth Annual Conference on Highway Engineering, at Ann Arbor, Mich.

A STUDY OF CRUSHING AND HEAVING OF CONCRETE PAVEMENT BASES

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Change in Practice

In recent years, throughout this section of the United States, it has been noticed, that there has been a more pronounced tendency for the Portland cement concrete pavement bases, through some cause, to expand a sufficient amount to cause an unusual number of failures of such bases due to the crushing of the concrete. During the same period of time the use of gravel as an aggregate has increased very rapidly and mixtures much richer than those used in earlier construction are now general, developing strength, in most cases, at least twice that of the older concrete bases. The number of these failures has made it imperative that information be gathered relating to their causes with the view of avoiding them in the future, if possible.

The older bases used in this section of the United States were constructed with a mixture of approximately 1 part of cement to 3 parts of sand and 6 parts of broken limestone. The limestone used had the following chacteristics.

Weight per cu. ft.	165 lbs.
Absorption, per cu. ft	1 lb.
French coefficient of wear	8
Toughness	6
Hardness	14

A large yardage of these bases was constructed by the use of natural cement instead of Portland cement. Heaving and crushing of these old bases was practically unknown regardless of whether Portland cement or natural cement was used as a cementing medium. A mixture of sand and this limestone in the proportions of 1:3:6 develops a strength of approximately 1,300 lbs. per sq. in. in 28 days, 1,600 lbs. per sq. in. in one year and 1,800 lbs. per sq. in. in two years.

The gravel aggregate more recently used in the richer and stronger concrete mixtures has been composed of Platte Valley aggregate known commercially as sand-gravel. This material is composed entirely of particles derived from granite. The average mechanical analysis of sand-gravel is as follows.

Silt and clay	None
Passing 100-mesh sieve	1%
Passing 40 and retained on 100-mesh sieve	8%
Passing 20 and retained on 40-mesh sieve	20%
Passing 10 and retained on 20-mesh sieve	20%
Passing ¼-in. and retained on 10-mesh sieve	36%
Retained on ¼-in. sieve	15%

A mixture of sand-gravel, as described above, in the proportion of 1:6 will develop a compressive strength of approximately 1,300 lbs. per sq. in. at the age of 28 days, 1,900 lbs. per sq. in. at the age of one year, and 2,400 lbs. per sq. in. in two years. An inspection of these strengths would indicate that they are in excess of those used in earlier construction at all ages except 28 days. During the past few years, however, there has been a tendency to use this aggregate in richer mixtures for base construction, usually a mixture of 1:5. Such a mixture will develop a compressive strength of approximately 2,000 lbs. per sq. in. at the age of 28 days, 2,600 lbs. per sq. in. at the age of one year and 3,200 lbs. per sq. in. at the age of two years.

It would seem at first thought that the richer, 1:5 mixtures were better on account of the greater compressive strength but it has been observed that there are many more places where crushing and heaving occurs in this mixture than where the 1:6 sand-gravel mixture is used. Further, there is more heaving and crushing in the 1:6 gravel mixture than where the 1:3:6 limestone-sand aggregate has been used. The trouble from heaving and crushing of the concrete usually arises at an age of approximately one year.

In an attempt to trace out the causes for the difference in performance of the various mixtures and types of aggregate it was reasoned that the mixtures that are deformed the greatest amount before crushing occurs are least likely to become crushed due to expansion, provided, of course, that the amount of expansion due to temperature changes and variations in moisture content is the same for all mixtures. Since in the pavement base there is very little, if any, change in volume of the concrete with changes in temperature and moisture content then the normal amount of elongation of the pavement slab, due to temperature changes and changes in moisture content, must be taken up by stress in the concrete.

Deformation at the Breaking Load

To arrive at the amount of expansion that may be taken care of through stress it is necessary to determine the amount of deformation that each mixture is capable of undergoing before rupture occurs. This was done by making simultaneous readings of load and deformation at frequent intervals throughout the compressive strength test. The stress-

deformation diagram was then plotted for each test and the curve prolonged from the last reading of both values until it intersected the value of the breaking load. From this data it was interesting to notice that the value of what was called the "Modulus of Elasticity at the Breaking Load" for given mixtures was more nearly a uniform value than the secant modulus of elasticity at the 650 lb. per sq. in. load.

A long series of tests has been carried out determining the deformations of various mixtures of concrete at the breaking load. Table I gives the average results of these determinations.

Table II gives the coefficients of expansion per degree Fahrenheit as determined upon the same mixtures and with a temperature rise of from 70 deg. F. to 230 deg. F.

To determine the effect of increasing the moisture content in the concrete upon the length of the concrete test pieces, each piece was dried out, then allowed to cool to room temperature, about 70 deg. F., after which it was measured at that temperature, immersed in water for 48 hours and remeasured. The unit increase in length due to the moisture absorbed is given in Table III.

Effect of Rise in Temperature

If all other factors except change in temperature are ignored it may be calculated, from Tables I and II, just what temperature rise is necessary to cause failure in the concrete. In these calculations change in moisture content is ignored, as is also the fact that at the earlier ages, up to approximately 30 days, there is a shrinkage of the concrete if cured without immersion in water. This latter fact has been demonstrated by a number of investigators such as Messrs. Goldbeck, Fleming, and Berry.

Solving for temperature rise necessary to produce failure by compression, let us calculate the temperature rise for the 1:5 and 1:6 mixtures of sand-gravel aggregate, from the foregoing data. We find

TABLE I.—UNIT DEFORMATION OF CONCRETE AT THE BREAKING LOAD.

Aggregate	Mixture	Unit Deformation of Concrete at Breaking Load: Age, 28 Days	Age, One Year	Age, Two Years
Sand-Gravel	1:3	.00117		
Sand-Gravel	1:4	.00086		
Sand-Gravel	1:5	.00085	.00087	.00134
Sand-Gravel	1:6	.00074	.00112	.00150
Sand-Gravel	1:7	.00072	.00090	.00135
Limestone-Sand	1:2:4	.00101	.00163	.00125
Limestone-Sand	1:3:6	.00118	.00138	.00159

TABLE II.—COEFFICIENT OF EXPANSION PER DEGREE FAHRENHEIT.

Aggregate	Mixture	Coefficient of Expansion per Degree Fahrenheit. Age, 28 Days	Age, One Year	Age, Two Years
Sand-Gravel	1:3	.0000052	.0000052	.0000053
Sand-Gravel	1:4	.0000053	.0000053	.0000053
Sand-Gravel	1:5	.0000050	.0000052	.0000051
Sand-Gravel	1:6	.0000052	.0000051	.0000051
Sand-Gravel	1:7	.0000050	.0000050	.0000050
Limestone-Sand	1:2:4	.0000040	.0000036	.0000037
Limestone-Sand	1:3:6	.0000034	.0000038	.0000036

TABLE III.—UNIT INCREASE IN LENGTH CAUSED BY IMMERSION IN WATER FOR 48 HOURS.

Aggregate	Mixture	Age, One Year: Increase in Weight	Unite Increase in Length	Age, Two Years: Increase in Weight	Unit Increase in Length
Sand-Gravel	1:3	4.74%	.000290	4.54%	.000251
Sand-Gravel	1:4	4.93%	.000211	4.73%	.000203
Sand-Gravel	1:5	5.20%	.000196	4.80%	.000180
Sand-Gravel	1:6	5.11%	.000214	5.27%	.000209
Sand-Gravel	1:7	5.67%	.000189	4.53%	.000165
Limestone-Sand	1:2:4	4.30%	.000226	4.09%	.000201
Limestone-Sand	1:3:6	4.19%	.000210	4.12%	.000166

TABLE IV.—TEMPERATURE RISE TO PRODUCE FAILURE, IF MOISTURE CHANGE AND SHRINKAGE AT EARLIER AGES IS IGNORED.

Aggregate	Mixture	Temperature Rise to Produce Failure, If Moisture Change and Shrinkage at Earlier Ages Is Ignored: Age, 28 Days	Age, One Year	Age, Two Years
Sand-Gravel	1:3	225°F.	167°F.	263°F.
Sand-Gravel	1:4	162°F.	220°F.	294°F.
Sand-Gravel	1:5	170°F.	180°F	270°F.
Sand-Gravel	1:6	142°F.	453°F.	338°F.
Sand-Gravel	1:7	144°F.		
Limestone-Sand	1:2:4	252°F.	363°F.	442°F.
Limestone-Sand	1:3:6	347°F.		

that in the case of the 1:5 mixture we get a temperature rise of 167 deg. F. by dividing 0.00087, the deformation to produce failure at an age of one year, by 0.0000052, the coefficient of expansion at the same age. For the 1:6 mixture we get a temperature rise of 220 deg. F. to produce failure, by dividing 0.00112 by 0.0000051. Table IV gives the temperature rise to produce failure in each of the mixtures, at various ages, if we ignore the factors mentioned above.

Other investigators have proven that there is a unit shrinkage of concrete during the first thirty days, due to curing in air, which will amount to from 0.0001 to 0.0003 depending upon the mixtures used and the type of aggregate. To produce a temperature expansion equivalent to this shrinkage, at the age of 28 days would require a temperature rise of from 20 deg. to 60 deg. F., let us say 40 deg. F. Forty degrees should, therefore, be added to the values of temperature at the age of 28 days to arrive at the temperature that would cause the base to crush at that age. The temperature change at that age can never be as great as this amount, and since the moisture is decreasing instead of increasing there can be no increase in volume due to change in moisture content at this age. For this reason crushing does not occur at the earlier ages.

The shrinkage at the earlier periods causes the base to crack. If these cracks are sufficiently opened to allow dirt to collect in them and expansion subsequently takes place the original condition of the concrete may be taken as though its length were that of concrete already set. This being the case, it is readily seen that the critical point in the life of the base, as far as our data extends, is that at the age of one year. But even at that time temperature rise alone cannot cause the base to expand a sufficient amount to cause it to be crushed.

The relative value of the different mixtures and aggregates, compared upon the basis of their ability to resist crushing due to temperature rise may be arrived at by dividing their deformations at the breaking load by the total expansion due to a temperature rise of 90 deg. F. The result might be called the "Factor of Safety Against Crushing Due to a Rise in Temperature of 90 deg. F." Table V gives this value for the various mixtures.

The mixtures in the order of their ability to resist crushing due to expansion caused by rises in temperature, are the 1:2:4 limestone-sand concrete, 1:3:6 limestone-sand concrete, and 1:6 sand-gravel concrete.

Effect of Change in Moisture Content

Table III does not give a true record of what takes place within a pavement base as a result of changes in moisture content, yet it gives a relative comparison of the various mixtures and the two classes of aggregate. It also gives a true record of the amount of expansion in the concrete due to storing it in water for 48 hours after previously drying the samples.

The relative ability of the various mixtures to resist the effect of expansion due to immersion in water for 48 hours may be determined by dividing the deformation of the concrete at the breaking load by the unit expansion of the concrete due to immersion in water for 48 hours. The result of this calculation is as follows, and might be called the "Factor of Safety Against Crushing Due to Moisture Absorbed in 48 Hours."

Making the comparison of aggregates

TABLE V.—FACTOR OF SAFETY AGAINST CRUSHING DUE TO A RISE IN TEMPERATURE OF 90°F.

Aggregate	Mixture	Factor of Safety Against Crushing Due to a Rise in Temperature of 90°F. Age, One Yr.	Age, Two Yrs.
Sand-Gravel	1:5	1.9	2.9
Sand-Gravel	1:6	2.4	3.3
Sand-Gravel	1:7	2.0	3.0
Limestone-Sand	1:2:4	5.0	3.8
Limestone-Sand	1:3:6	4.0	4.9

TABLE VI.—FACTOR OF SAFETY AGAINST CRUSHING DUE TO MOISTURE ABSORBED DURING 48 HOURS.

Aggregate	Mixture	Factor of Safety Against Crushing Due to Moisture Absorbed During 48 Hours. Age, One Yr.	Age, Two Yrs.
Sand-Gravel	1:5	4.4	7.4
Sand-Gravel	1:6	5.2	7.2
Sand-Gravel	1:7	4.8	8.2
Limestone-Sand	1:2:4	7.2	6.2
Limestone-Sand	1:3:6	6.6	9.6

TABLE VII.—RISE IN TEMPERATURE NECESSARY TO PRODUCE THE SAME EXPANSION AS 48 HOURS IMMERSION IN WATER.

Aggregate	Mixture	Rise in Temperature Necessary to Produce the Same Expansion as 48 Hours Immersion in Water. Age, One Year	Age, Two Years
Sand-Gravel	1:3	56°F.	47°F.
Sand-Gravel	1:4	40°F.	38°F.
Sand-Gravel	1:5	38°F.	35°F.
Sand-Gravel	1:6	42°F.	41°F.
Sand-Gravel	1:7	38°F.	33°F.
Limestone-Sand	1:2:4	63°F.	54°F.
Limestone-Sand	1:3:6	55°F.	46°F.

and mixtures on this basis the 1:2:4 limestone-sand aggregate concrete is the best followed by the 1:3:6 and the 1:6 sand-gravel aggregate concrete.

It is interesting to notice how great the rise in temperature must be in order to produce an expansion in the concrete equal to that produced by immersion in water for 48 hours. Table VII gives this information.

There are many unusual conditions that might arise which would cause the expansion due to moisture changes to exceed the above amounts.

These tests were made for the Lyman-Richey Sand Company of Omaha, Neb., in connection with an investigation of concrete aggregates.

Conclusions

(1) Sand—Gravel concrete bases will resist destruction due to expansion in proportion to the amount they are capable of being deformed at the breaking load, since the coefficient of expansion of the various mixtures of the same aggregate are practically the same and the amount of expansion due to absorption of moisture is practically the same for mixtures leaner than 1:3 at the age of one year.

(2) Of all the sand-gravel aggregate concretes the 1:6 mixture offers the greatest resistance to crushing due to expansion and since it gives ample strength for pavement base construction it is the best mixture for that class of construction.

(3) The limestone aggregate concrete offers a greater resistance to crushing due to expansion than the sand-gravel aggregate concrete.

WHAT A REAL ESTATE EXPERT CAN DO FOR A CITY

By Edward Grieb, City Real Estate Agent, City Hall, Milwaukee, Wis.

In a large majority of cases where American Municipalities acquire real estate by purchase, the price is an exorbitant one. The cause of this may sometimes lie in city officials being unduly influenced to promote the purchase at an exorbitant price. Or it may happen that the responsible city officials, though inspired by the most honorable intentions, err, to the city's loss, through ignorance of true property values. In almost all cases there is the added factor of potential loss due to the fact that the municipality has no trained real estate buyer through whom to conduct the transaction; for, as every realtor knows, a competent buyer, thoroughly versed in real estate values and trained to make the most of all psychological factors in his own favor, is able to secure far more advantageous terms than can be secured by the relatively untrained buyer, however intelligent.

Where a municipality acquires real estate under condemnation, the price allowed is invariably high and sometimes exorbitant. If the municipality retains able real estate experts, the tendency of the jury to allow an exorbitant price will be restrained to the point where the amount awarded is perhaps only 10 per cent or 20 per cent higher than the fair value. When, however, the city fails to provide such experts, condemnation proceedings often establish the price at 50 per cent or more above a fair value. It is conservative to estimate that the City of Milwaukee prior to the establishment of the position of City Real Estate Agent, has paid on an average of 50 per cent more than it should have done.

In the decade previous to 1922, Milwaukee was actively engaged in formulating a City Plan. By 1922 this plan had become sufficiently definite to justify proceeding with certain portions of it, notably the civic center and a great widened avenue, which will serve both as an approach thereto and as a main traffic thoroughfare through what will ultimately be the heart of the business district. The contemplated purchases of real estate required for this project represented an assessed valuation of approximately $8,000,000. Other city planning projects and a normal program of real estate pur-

chases for schools, parks and playground purposes, would bring the real estate transactions in immediate contemplation up to approximately $12,000,000.

It was recognized by His Honor the Mayor, by the Board of Public Land Commissioners (City Planning Commission), by some of the progressive members of the Common Council, by the City Club and by other Civic organizations that if these extensive real estate purchases were to be made by the methods previously followed, the City would pay millions of dollars in excess of a true value. It was generally recognized that the City of Milwaukee could solve this problem only by securing for itself the same competent service in the real estate field that is generally obtained by large private operators in real estate. The idea, therefore, of creating the position of City Real Estate Agent received general support without respect to partisan or group politics and was made effective through an ordinance establishing this position as of January 1, 1922.

The position of City Real Estate Agent was made subject to the control of the Board of Public Land Commissioners (City Planning Commission). This Commission is an entirely independent body whose members, appointed by the Mayor, serve without pay. It has full right to initiate purchases, formulate policies and recommend action, but its recommendations are subject to approval by the Common Council, to which body the Commission has, in effect, the relationship of a special or advistory committee. The appointment of the City Real Estate Agent lies with the Commission and his work is under its direction.

Under these conditions, the City Real Estate Agent has a primary responsibility to secure real estate desired by the city at no more than its fair value. The terms secured and recommended by the City Real Estate Agent must first pass the scrutiny of, and be approved by, the Public Land Commission and finally accepted by a vote of the Common Council before the City is bound by those terms. Under these conditions, it is felt that the public has a guarantee of honest service in addition to that afforded by the character and integrity of the individual who may hold the position of City Real Estate Agent. With such scrutiny provided for his acts, it is unlikely that the City Real Estate Agent, even should he be so inclined, could mulct the City to any material extent.

In the year and one-half during which Milwaukee has been proceeding to acquire desired real estate through its City Real Estate Agent, options have been secured on property having an assessed valuation of $2,156,075, the purchase price under these options totaling $2,091,577. For various reasons it has been possible to purchase for considerably less than the options secured. The assessed valuation of property purchased through the City Real Estate Agent has been $1,161,920, the purchase price of said property totaling $1,075,065.

The basis of assessment in Milwaukee, according to law, is 100 per cent of the true value. In view of the fact that previous purchases of property have never been as slow as the assessed valuation and have averaged at least 50 per cent above the assessed valuation, the enormous savings made possible by the activities of the City Real Estate Agent are apparent.

So well satisfied are the Officials and people of Milwaukee with this method of handling real estate purchases that two additional positions of Assistant City Real Estate Agents, one at $5,000 and the other at $4,000 per year, have just been created. While it is realized that the salaries paid to the City Real Estate Agent and his assistants are far less than they could command in private activities it is significant that they are on a par with the salaries paid to the chief municipal executives in legal, engineering and administrative lines. The opportunity for honorable public service is a material factor in attracting to these positions men of the caliber which the opportunities of the position demand.

It frequently happens that a city purchases real estate which, for some years, is not used for the purpose for which it was purchased. Quite generally such real estate is rented to private parties at a low rental. Under the Milwaukee plan, the management of such real estate is placed in the hands of the City Real Estate Agent, his arrangements, however, being always subject to the approval of the Common Council and the Public Land Commission. This has resulted in assuring to the City the most effective management of such real estate.

There is a development now in progress relative to assessment of benefits or damages, whether accruing from street widening, paving, or any other form of public improvement. The law stipulates that only the actual cost may be assessed

as benefits, regardless of what they may be worth, the surplus value, if any, going to the property owner as unearned increment. It has been the custom throughout the country to declare the benefits equal to the cost arbitrarily, or to an arbitrary percentage, regardless of its relation to the actual cost. Although there has been no recent legislation assigning the supervision of these assessments to the City Real Estate Agent, however, those officials or Boards having such determination in charge are in a co-operative spirit voluntarily referring such matters to the Real Estate Agent. This practice is becoming a custom and is encouraged by the beneficial results experienced therefrom.

In such work the City Real Estate Agent has endeavored to make a fundamental study determining the true benefits or the true damages accruing to the property, as measured by the former and new sales value of the property. It is believed that the work in this direction holds great promise, on the one hand, of proving that the study of real estate values can be placed on a more scientific foundation than has heretofore been recognized and, on the other hand, of more justly determining benefits or damages accruing to the private citizens through public improvements.

It has been the comment of the City Club and other Civic organizations interesting themselves in public affairs that the method of purchasing real estate herein reported have not only already saved the city hundreds of thousands of dollars, but have been an important factor in awakening a higher public ideal. The work has directed public attention to the fact that the city has been badly exploited in the past in real estate purchases. Under the new conditions there have been several instances where certain property owners, individuals heretofore regarded as selfishly considering only their own interest, have come forward with fair and even generous offers to the City. Where the reverse has been the case, where political influence has been invoked to secure exorbitant prices, the exposure of such methods by the City Real Estate Agent has resulted in such public reprobation as to discourage other attempts of a like nature. The work, therefore, has also emphatically suggested and promoted a higher civic morality in this respect.

THE DESIGN AND CONSTRUCTION OF ASPHALT PAVEMENTS

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Asphalt pavements are pavements in which the wearing course consists of mineral fragments bound together with asphalt cement. Some few attempts have been made to substitute other materials for the mineral aggregate, but the total yardage of such pavements laid in the past is so small that they may be disregarded.

The term "wearing course" in this paper will be restricted to a course of asphalt bound mineral fragments not less than 1 in. thick in order to distinguish between asphalt pavements proper and roads or pavements which have been merely surface treated with asphalt or road oils of an asphaltic nature. The asphalt wearing course which is seldom constructed less than 1½ in. and frequently 2 or 2½ ins. thick may be laid directly on any type of foundation or on an intermediate course 1 to 2 ins. thick of an asphaltic type which in certain designs is termed the binder course.

In other designs the foundation itself is constructed with an asphalt bound mineral aggregate of any desired thickness in which case the term "black base" or asphalt base pavement is used to describe the structure. The asphalt base may be placed directly upon the proposed subgrade or upon a sub-base course of gravel or broken stone. In any event the asphalt base is laid to a greater thickness than the usual binder course, seldom less than 3 ins. and sometimes as thick as 6 ins.

Constituents of Asphalt Pavements

Mineral Aggregate—In all asphalt paving combinations whether wearing course, binder or base the mineral aggregate is the predominating constituent and forms the body of the structure. Its characteristics including physical properties and grading have fully as much effect upon the serviceability of the pavement as have the characteristics of the asphalt cement with which it is combined. A wide range of mineral products may, however, be successfully used in asphalt construction if care is exercised in the selection of a suitable type of pavement, for the mineral aggregate which it is desired to use for any individual case. It is, therefore, of rare occurrence that local mineral aggregate cannot be used in the

construction of some type of asphalt pavement. Thus gravel, broken stone, broken slag, sand, stone dust and even clay can all be utilized if properly selected and used.

When the mineral aggregate consists of relatively large angular fragments a certain stability of the paving structure, which is not possible with an aggregate consisting of fine mineral particles, may be secured by the keying together or interlocking of these fragments under compression even when the large voids are not packed with other material. This fact makes practicable the construction of the simplest type of asphalt pavement, known as the asphalt macadam in which the asphalt is applied after the mineral aggregate has been laid. If the large fragments are rounded as in the case of most gravels a thorough packing of the large voids is necessary to secure stability and as it is practically impossible to pack such voids after applying the asphalt and impossible to coat the fragments with asphalt after the voids have been packed a mixed type of construction must be used. All fine mineral aggregate composed of particles of less than 1 in. diameter must also for obvious reasons be mixed with asphalt prior to being placed in the pavement structure.

The bulk of all mineral aggregates used in the construction of wearing courses should be reasonably resistant to wear and should be composed of hard durable fragments which will not fracture under traffic. Paving mixtures must be proportioned so as to contain sufficient asphalt to coat and bind together all particles of the mineral aggregate, but cannot carry a sufficient excess of asphalt adequately to cover a much greater surface area of mineral particles than that originally present, without producing a mushy, unstable mixture.

For this reason if the mineral fragments in the wearing course of a mixed asphalt pavement tend to fracture under traffic, ravelling and disintegration of the wearing course takes place. Toughness or resistance to fracture is, of course, not as important a consideration where the mineral aggregate is protected from the direct action of traffic by being placed below the wearing course as in the construction of an asphaltic concrete base. If for any reason it is necessary to use a rock of relatively low toughness in an asphalt wearing course the asphalt macadam is probably the safest type to adopt for the reason that stability is secured principally by an interlocking of the mineral fragments and because of the method of construction more asphalt is present near the surface than absolutely needed to bind the fragments together. Occasional fractures are therefore cared for by this excess of asphalt.

Relatively high resistance to abrasion of the mineral particles of the wearing course is, of course, desirable for any type of pavement, but in asphalt pavements constructed with a seal coat fairly soft rock may be successfully used, particularly if it is of a calcareous nature. It is well known that a mixture of asphalt with pulverized limestone makes an exceedingly tough mastic, and such a mastic is slowly produced on the surface of an asphalt pavement constructed with limestone provided sufficient asphalt is present to combine with the dust produced by abrasion of the coarse fragments.

Asphalt—The principal function of asphalt in an asphalt cement is to bind together the mineral fragments which constitute the body of the road structure. Asphalt paving cements are plastic by nature and when used as a coating or binding medium for mineral aggregates produce a structure which is to a considerable extent flexible. This fact sharply differentiates asphalt pavements from those constructed with hydraulic cements which produce rigid structures, and has a most important bearing upon the selection of cross-sectional designs and any comparison of such cross-sections with those of a rigid nature.

The properties which an asphalt should possess in order to function properly in a pavement structure are generally understood and specifications for paving asphalt have been pretty well standardized. Because there are a number of different types of asphalt pavement using mineral aggregates of different degrees of natural stability and because the consistency of an asphalt cement varies with its temperatures, thus producing a variable degree of flexibility in the pavement structure, a single grade of asphalt cement cannot be used for all types of asphalt pavements. This has led to the establishment of a number of well defined grades as determined by the hardness of the product measured in terms of the penetration test. During 1923 nine standard grades of asphalt for asphalt pavement construction were unanimously adopted by a conference of consumers and producers called by the

United States Department of Commerce and these grades are now being generally adopted throughout the country.

The success of an asphalt pavement depends not only upon the characteristics of the mineral aggregate and the asphalt cement, but upon the proportions in which they are combined. The allowable variation in proportion of asphalt cement which should be used with any mineral aggregate is very limited as compared with hydraulic cements, and it is quite as serious a mistake to use too much asphalt as too little in the construction of the pavement. As a matter of fact determination of the correct amount is just as important if not more important than the selection of the best grade or consistency of asphalt to use. The use of too little or too hard an asphalt in general reduces the flexibility of the pavement which then at low temperatures acquires certain of the inherent and unavoidable faults of the rigid pavement. On the other hand, use of too much or too soft an asphalt may increase the flexibility of the pavement to such an extent as to make it readily plastic and subject to displacement under traffic. Fortunately, however, experience and careful observation over a period of more than 40 years have resulted in a standardization of practice which if conscientiously followed insures highly satisfactory results.

Types of Asphalt Pavements

There are four well defined types of asphalt pavements, each having certain characteristics which favor its selection in preference to the others for certain combinations of local conditions. In many cases, however, selection between at least two types is more a matter of preference based upon previous local experience or relative first cost than upon any other considerations. These four principal types are (1) Asphalt Macadam, (2) Asphaltic Concrete, (3) Sheet Asphalt, and (4) Asphalt Block. In a paper of this nature it is unnecessary to attempt a full discussion of all of the details of construction of these types which have been thoroughly covered in numerous engineering papers and specifications already published. Attention will, therefore, be directed to only a few of the more important features relating to characteristics, selection, design and construction.

Asphalt Macadam

The asphalt macadam wearing course is usually constructed from 2½ to 3½ ins. thick depending to a considerable extent upon the quality of the mineral aggregate which is available for use. This ordinarily consists of broken stone, although mine tailings or crushed slag also make satisfactory products if properly selected. It is necessary that the fragments be angular and except for sealing the surface that they be of fairly uniform size. Crushed gravel may be substituted for broken quarry stone provided it is produced by crushing only that portion of the gravel which fails to pass a 3½ in. screen. For rock which has a per cent of wear of not more than 7 it is customary to use for the body of the wearing course fragments which pass a 2½ in. screen and are retained on a 1¼ in. screen in which case the finished wearing course is made approximately 2½ ins. thick. If a softer rock only is available it is desirable to increase the average size of the fragments to material which passes a 3 or 3½ in. screen, in which case the thickness of the wearing course is correspondingly increased.

The coarse broken stone is spread over the prepared foundations and rolled until the fragments interlock after which melted asphalt cement of 85 to 100, 100 to 120, or 120 to 150 penetration depending upon traffic and climatic conditions is applied uniformly over the surface at a rate of 1½ to 2 gals. per sq. yd., according to the thickness of the wearing course. Surface voids are then filled by rolling in a smaller broken stone product which is lightly broadcasted over the surface, after which a seal coat of hot asphalt is applied at the rate of approximately ½ gal. per sq. yd. and covered with stone chips which are rolled in until thoroughly bonded.

Things to Watch in Asphalt Macadam Construction

Without discussing reasons which in most cases are obvious it may be stated that the following details are of vital importance in the construction and maintenance of a high class asphalt macadam pavement. The slighting of any of these details is likely materially to shorten the useful life of the pavement, although the bad effects may not begin to be seen until some time after construction is completed.

1. The individual fragments of coarse mineral aggregate should be clean and free from dust so that the hot asphalt cement will readily adhere to their surfaces.

2. Before the first application of as-

phalt is made the fragments of mineral aggregate should be well keyed together by rolling or otherwise an uneven surface will develop under traffic due to shifting about. Rolling should not, however, be carried to the point of abraiding the fragments so as to produce a coating of stone dust on their surfaces.

3. Before application of the asphalt the course of broken stone should show a uniform distribution of voids. Pockets of fine material which prevent uniform penetration of the asphalt should be removed and replaced with mineral aggregate of suitable size.

4. Asphalt should be applied only when the broken stone course is dry for its entire depth and when the weather is sufficiently warm to prevent chilling of the asphalt at the surface to such an extent that proper penetration will not be secured.

5. Great care should be taken to distribute the asphalt at a uniform rate per square yard, both during the first application and in the construction of the seal coat.

6. After the seal coat asphalt has been applied only sufficient stone chips should be rolled in to take up the excess asphalt. Overloading the seal coat with mineral matter materially shortens its life.

7. The seal coat of the asphalt macadam should be carefully maintained and before it has completely worn away the surface should be again treated with an application of asphalt and stone chips. Such retreatment will greatly prolong the life of the underlying wearing course.

Asphaltic Concrete

Asphaltic concrete wearing courses are usually constructed 2 in. thick. They are composed of a mixture of asphalt cement with broken stone, mine tailings, broken slag or gravel and usually with sand and mineral filler as well. The mixture is ordinarily prepared at an asphalt plant from preheated mineral aggregate and asphalt and while hot is laid and compressed upon the prepared foundation. Certain patented or proprietary asphaltic concrete mixtures are, however, prepared or laid without preheating the constituents. There are two main classes of asphaltic concrete known as coarse graded aggregate and fine graded aggregate. In the former the proportion of mineral particles larger than ¼-in. diameter is greater than any other constituent of the mix, the fine aggregate which consists of sand and mineral filler serving principally as void filling material between the larger mineral fragments. In the fine graded aggregate asphaltic concrete, on the other hand, sand or fine mineral particles which will pass a 10-mesh sieve predominate and the larger fragments are merely suspended in the matrix of fine aggregate without being in immediate contact with one another.

In preparing coarse graded asphaltic concrete it is customary to screen the hot aggregate into two sizes, coarse and fine, and to recombine them in the proportion of about 2½ to 1 by weight. Mineral filler most of which will pass the 200 mesh sieve is then added to the extent of about 5 per cent of the total mix. From 5 to 8 per cent of asphalt cement is required to coat and bind the aggregate into a dense homogeneous mass. After spreading, raking and rolling this mixture develops a surface of rather open texture which requires a seal coat. Such a seal coat may be constructed with a surface treatment of asphalt followed by an application of stone chips applied in much the same manner as described for the asphalt macadam. The coarse aggregate for this class of pavement is usually required to pass a 1¼-in. screen and be retained on a ¼-in. screen. It should be composed of sound, durable particles which will not fracture under traffic but because of their relatively large size and the fact that voids are well packed with fine aggregate the particles need not be angular. Opportunity is therefore offered for the utilization of a good grade of local gravel. This together with the fact that the sand or fine aggregate need not meet as rigid grading requirements as for other classes of asphalt paving mixtures create an advantage which in certain instances may be a deciding factor in the selection of type.

Fine graded asphaltic concrete is so similar in character to the wearing course of a sheet asphalt pavement as to have acquired the term "stone filled sheet asphalt." The great bulk of the mixture consists of carefully graded fine mineral aggregate meeting all the requirements for sheet asphalt but may consist partly of stone screenings as well as sand. The mixture usually carries from 20 to 35 per cent of coarse aggregate which will pass a ⅝-in. or ½-in. screen and be retained upon a 10-mesh sieve, from 7 to 11 per cent of mineral filler passing a 200-mesh sieve and from 7.5 to 9.5 per cent of asphalt. The coarse aggregate should pref-

erably be of hard, durable broken stone or slag which produce a rather rough texture surface but not one which requires a seal coat. The use of gravel pebbles for coarse aggregate should be avoided as they are likely to be picked out of the surface of the pavement by traffic and leave small holes which serve as starting points for progressive surface disintegration. This class of asphaltic concrete has become quite popular in certain sections, particularly where coarse aggregate is more expensive than fine aggregate, and offers many of the advantages of sheet asphalt usually at a lower cost.

Sheet Asphalt

Sheet asphalt pavements are those in which the wearing course is composed of a mechanical mixture of asphalt cement with a carefully graded sand and mineral filler. This mixture is often called sheet asphalt topping or surface mixture and is usually laid on an intermediate course of asphaltic concrete known as the binder course. The total thickness of binder and wearing courses is generally 2½ or 3 in. with a minimum thickness of 1 in. for either course. One and one-half inch binder and 1½-in. wearing course is probably the most common design adopted for the sheet asphalt pavement. The binder mixture is similar to the usual coarse aggregate asphaltic concrete except that it carries a smaller percentage of sand and no mineral filler as it is not necessary to completely fill the voids and it is desirable to obtain a surface texture after compaction which will permit a close bond with the wearing course. Sheet asphalt is designed to withstand severe traffic conditions and has become the most popular of all city pavements as evidenced by the yardage laid as compared with all other types. Particular attention should be paid to securing a sand for the wearing course composed of hard durable grains free from clay, loam and other foreign material and meeting the well standardized mesh composition or grading limitations which experience has shown to be desirable and which are embodied in most sheet asphalt specifications. The topping mixture is composed of from 70 to 80 per cent of sand, from 10 to 20 per cent of mineral filler passing the 200 mesh sieve and from 9.5 to 12.0 per cent of asphalt.

In both fine aggregate asphaltic concrete and sheet asphalt paving mixtures mineral filler plays a very important role. It not only serves to fill the voids between the fine aggregate or sand particles but serves to toughen the mixture and increase its resistance to displacement under traffic. Very fine sand grains do not serve the latter purpose satisfactorily, but such materials as limestone dust, portland cement and slate dust, have proved to be excellent fillers and are usually specified for this purpose. It is ordinarily advantageous to use as much filler as the mix will comfortably carry without interfering with its uniform spreading and compaction. This is largely dependent upon the amount of sand passing the 80-mesh sieve which is present in the fine aggregate. Except for mechanical difficulties attending its use dry clay free from lumps or balls makes a satisfactory filler and as a matter of fact, it may be noted that a patented type of pavement has been devised in which the mineral aggregate consists entirely of clayey earth at least 40 per cent of which should pass the 200 mesh sieve.

Hot-Mix Construction

The most desirable consistency or grade of asphalt for use in asphaltic concrete and sheet asphalt pavements is largely determined by climatic and traffic conditions to which the pavement will be subjected. In general the warmer the climate and the heavier the traffic the harder should be the asphalt cement. For asphaltic concrete penetration limits of 40 to 50, 50 to 60, or 60 to 70 are commonly specified and for sheet asphalt the usual limits are 30 to 40, 40 to 50, or 50 to 60. The following construction details should be given particular attention in order to secure best results with any of the hot mix types of asphalt pavements.

1. The character and grading of the mineral aggregate should be under the constant and careful control of an inspector at the paving plant.

2. All batches of paving mixture should be correctly and uniformly proportioned preferably by weighing each constituent of the mix, and the plant inspector should be sufficiently experienced to determine just what proportions within specification limits are most desirable to adopt.

3. Paving mixture should leave the plant at such temperature, within specification limits, as will insure its arrival on the job at a sufficiently high temperature to permit of proper spreading, raking and compaction.

4. The mixture should be laid only when weather conditions are such that the surface is not rapidly chilled, thus

forming a stiff crust which prevents proper compression throughout its entire depth.

5. Careful and uniform spreading and raking are essential to securing a surface of uniform contour. Carelessness in this detail cannot be corrected by rolling and an uneven contour in a newly constructed pavement is apt to lead to rapid development of waves or bumps.

6. The hot mixture should be compressed as soon as possible after raking and should be conscientiously continued by an experienced roller man until no further compaction is possible. Rolling should proceed at an average rate of not more than 200 sq. yds. per hour per roller. Maximum initial compression is highly desirable and may frequently best be obtained by using a 3-wheel 10 or 12-ton roller.

7. The contour of the pavement should be tested before rolling is discontinued and corrected where necessary by suitable means before the mixture has become cool.

Asphalt Block

The fourth type of asphalt pavement known as asphalt block is a pavement in which the wearing course is constructed of blocks composed of a dense fine graded asphaltic concrete subjected to heavy compression during the process of moulding. These blocks are laid in regular courses as in the case of brick pavements and vary in thickness from 2 to 3 in. A special grade of asphalt differing in certains respects from the regular paving asphalts is required for asphalt block manufacture. Asphalt blocks should ordinarily be laid upon a ½-in. bed of cement sand mortar although they have been successfully used under favorable climatic and traffic conditions in certain localities directly upon a sand foundation.

Foundations

There are fully as many types of foundations which are satisfactory for use with asphalt wearing courses as there are types of asphalt pavements. Thus gravel, broken stone, Telford, portland cement concrete, and asphaltic base, commonly known as black base, all have their place in the design of asphalt pavements. Moreover almost any type of existing road or pavement which has reached its limit of economic and useful life as a wearing surface may be utilized in some way as a foundation for a new asphalt pavement. The annual salvage value of such old worn out roads in this country is tremendous and a large part of the original investment in their construction is lost if the old material is removed and replaced by a new type of construction. This portion of the original investment which for old worn out gravel and macadam roads alone has been estimated at about $200,000,000 annually may be conserved by utilizing the old roads as foundations for asphalt pavements.

In this paper time will not permit a detailed description and comparison of all of the types of foundations available for use with asphalt pavements. The subject of foundations will therefore be treated in a rather sketchy manner with an attempt to develop some of the more fundamental factors relating to design.

Subgrades

First of all it is necessary to consider subgrades. For some years past much has been said and written regarding the importance of subgrade preparation and drainage but little real improvement is to be noted in ordinary practice. It has been demonstrated that all known systems of drainage have decided limitations of effectiveness and that the bearing power of certain soils under natural local conditions will in spite of drainage be so low as to necessitate the adoption of relatively costly designs of pavements to carry the traffic. It is also known that subgrades composed of certain soils will with ordinary drainage successfully carry almost any traffic if their surface is protected with a thin pavement which will not shatter under impact. Economical methods of modifying the characteristics of soils of poor quality so as to greatly increase their bearing value when wet have also been known for many years as evidenced by the widespread development of the sand clay road and yet in the construction of high type pavements this information is not put into practical use. The subject of subgrade modification is, however, receiving the constantly increasing attention of those actively engaged in highway research and it is to be hoped that construction engineers will soon begin to reduce the test results to practice. In the last analysis foundation construction, for flexible pavements at least, may be considered largely as a method of subgrade reinforcement.

Gravel and Broken Stone Foundations

A new gravel foundation should be allowed to consolidate and season under traffic for a period of at least six weeks before an asphalt pavement is placed upon it and during this period it should

be carefully maintained so that there will be no uneven, loosely-bound areas to cause breaks or depressions in the asphalt wearing course. It is also highly desirable to follow the same practice where a new broken stone foundation is to be used and during construction the voids should be filled with screenings so as to obtain as nearly as possible the same degree of stability as is found in old well constructed macadam roads. For a 2-in. asphalt pavement a new gravel foundation should seldom be less than 8 in. thick and a new broken stone foundation seldom less than 6 in. thick. Where the subgrade is of poor quality and the traffic heavy considerably thicker designs should be adopted. As a matter of fact under such conditions it is much safer to adopt some type of asphalt base with a relatively thin sub-base of gravel or broken stone.

Asphalt Foundations

There are three types of asphalt bases or foundations known as the asphalt macadam base, the asphalt sand base and the asphaltic concrete base. Asphalt macadam base is constructed in one or two courses, 3-in. thick in much the same manner as the asphalt macadam wearing course except that somewhat less asphalt is required per inch of thickness and the seal coat is omitted.

The asphalt sand base which has been successfully used in certain sandy sections of the country, notably the eastern portion of North Carolina and in Florida, is composed of a mixture of local sand and asphalt prepared and laid hot to a compacted thickness of 3 or 3½ in. directly upon the sandy subgrade. Such a base carrying a 1½ or 2-in. sheet asphalt wearing course has proved highly serviceable and economical for light and medium traffic.

The most extensively used type of asphalt foundation is the asphaltic concrete base which is composed of a coarse graded asphaltic concrete quite similar in character to that used for asphalt binder course, except that the maximum diameter of the coarse mineral aggregate may be as great as 2½ in. Durable pavements have been constructed in the State of California with an asphaltic concrete base only 2½ in. thick, and an asphaltic concrete wearing course 1½ in. thick but in most cases the thickness of the base is not less than 3 in. and may run as high as 6 in. which is then laid in two courses. Where subgrade conditions are bad and traffic heavy it is often desirable to lay a 3 or 3½-in. asphaltic concrete base upon a sub-base of broken stone 3 to 5 ins. thick. A relatively thin asphaltic concrete base may also be advantageously used to salvage an old gravel or macadam road which is too thin to be used directly as a foundation and is thus made to serve as a sub-base.

Asphalt base pavements have become very popular in a number of our Western States due to the highly satisfactory service results which many of them have given over a long period of years. For example, there are in existence in California over 2,000,000 sq. yds. of asphalt base pavements which have been in use for more than ten years and are in excellent condition today. It is also of interest to note that from 1918 to 1922 inclusive over 15,000,000 sq. yds. of asphalt base pavement were constructed in the five Pacific Coast States and that in addition over 7,000,000 sq. yds. were constructed in those states during 1923. This type of construction is extending eastward and promises to develop rapidly as eastern engineers become more familiar with its desirable qualities. Virginia has let a contract for 5.5 miles of it on a heavily travelled highway leading from Richmond to Seven Pines. Thirteen miles of asphaltic concrete base pavement were constructed last year on the Toronto-Hamilton Route in the Province of Ontario, Canada, and a number of eastern cities and counties in this country are now specifying black base construction. In addition the State of North Carolina has constructed a considerable mileage of sand-asphalt base pavement during the past few years.

With the same amount of care in subgrade preparation there is probably less chance of failure in a flexible foundation such as the asphalt base than in a rigid type of foundation. This is due to the fact that because of its flexibility it seeks to maintain constant and intimate contact with the subgrade and thus utilizes the supporting value of the subgrade to the maximum extent. Under many conditions that produce cracking in a rigid foundation the slight yield of an asphalt foundation will maintain the pavement intact.

Rigid Foundations

In entirely new construction portland cement concrete is frequently used as a foundation for asphalt wearing courses. In cities where subgrade conditions are generally good a foundation thickness of 6 ins. is ordinarily ample to carry the

weight of traffic and if precautions are taken in country highway construction to see that the subgrade is properly prepared, consolidated and drained, more than 6 ins. of concrete foundation will seldom be required. In fact where subgrade conditions are favorable 5 ins. or even 4 ins. of concrete may be sufficient. The mix need seldom, if ever, exceed the proportions of 1:3:6 or 1 part of cement to 9 parts by volume of total aggregate. Use of a rich concrete base is not only an unnecessary extravagance but may actually produce less satisfactory results than the lean base. Especially where conditions tend to produce considerable movement through expansion and contraction any cracks formed in a rich base are apt to be wider than in a lean base, thus producing open joints and corners which are known to be one of the greatest sources of weakness in the all-rigid pavement. Moreover wide cracks in the foundation are almost invariably carried up through the wearing course of the asphalt pavement. For the same reason it is not considered advisable to place construction joints in the concrete foundation, although some tendency along this line has been manifested in recent designs of portland cement concrete bases.

At this point it is desired to direct particular attention to a matter which deserves the careful consideration of highway engineers. Within the past few years a number of important investigations have been conducted in which attention has been focused upon the behavior of the all rigid pavement under laboratory and field tests. These investigations have led to decided modifications in the design of concrete pavements, intended to remedy troubles which have developed in the past, due to the formation of cracks and subsequent disintegration of the pavement under traffic. So much attention has been paid to concrete pavement design that a strong tendency has developed to view all designs though concrete spectacles and to apply to all other types of construction principles which under careful analysis may be found to be of very minor importance to such other types, particularly those which are flexible or semi-flexible in character.

Thus under ordinary conditions a very slight deflection of a concrete pavement slab under a traffic load develops a crack which is considered to be a failure as the crack starts progressive disintegration of the pavement. Yielding of the subgrade to the extent of a small fraction of an inch will cause cracking unless the slab is designed with sufficient strength to bridge this weakness in the subgrade. On the other hand while the concrete base of an asphalt pavement cannot deflect without cracking any more than a concrete pavement, when it does it is kept in contact with the subgrade, which prevents further appreciable deflection. The flexible asphalt wearing course adjusts itself to the slight permanent deflection caused by the cracking of the base without failure of any sort and for all practical purposes the pavement remains intact. No surface cracks leading to progressive disintegration are produced and the slight readjustment of contour extends over a sufficiently wide area to make it practically imperceptible. It has been repeatedly noted during impact investigations that the mere cracking of the concrete base under the application of loads does not produce failure of the asphalt wearing course.

It is true that wide cracks in a concrete base are sometimes carried through the asphalt pavement but in general cracks produced in foundations by surface loads are not wide and are no more serious than the fine cracks produced in lean bases by contraction. It is therefore hardly logical to design the concrete base of an asphalt pavement to meet the same strength requirement as for an all rigid pavement. To sum the matter up in a few words what constitutes failure in a concrete pavement does not constitute failure in an asphalt pavement. Attempts to apply the same principles of design to both types has resulted either in requiring an unnecessarily thick concrete base which is extravagant and prevents fair competition, or in requiring an unnecessarily rich mix base which not only hinders competition but may be disadvantageous for reasons previously mentioned.

Traffic Tests on Various Designs of Pavements

Two sets of traffic tests conducted on experimental sections of pavement in different parts of the country have recently been attracting considerable attention, not only of highway engineers but of the general public as well. I refer to the Pittsburgh, California, experiments and the Bates Road Tests, in Illinois. The Pittsburgh tests were confined to a study of concrete pavements only and nothing was developed of particular significance so far as concrete foundations are con-

cerned, although considerable valuable information relative to concrete pavement design was secured. It is hoped that the Pittsburg experiments will be continued, in which cases other types of pavement including asphalt will in all probability be studied.

The Bates Road Tests covered not only Portland cement concrete pavements but asphalt and brick pavements upon different types of foundations including concrete. The concrete foundations were perhaps unfortunately designed in some respects along lines foreign to the usual concrete base, producing conditions which while common to concrete pavements are abnormal in concrete bases. Thus every section of concrete base carried an open transverse joint producing corners which were plainly the cause of initial failure in those sections of asphalt pavement which failed under the test. Moreover on one side of the road traffic was run with the outer wheel directly on a concrete header made integral with the concrete foundation so that a considerable proportion of the traffic load was transmitted directly to the base without any protection of the asphalt top. Sections of all rigid, and rigid base pavements were reported to have failed when they developed a well-defined corner failure in the concrete. It is believed, however, that this criterion of failure is not a logical one to apply to asphalt pavements on a concrete base for reasons previously discussed.

The speaker has discussed the Bates Road Tests in considerable detail in a paper published last year and will not here attempt to repeat such discussion. The behavior of the various test sections, however, in his opinion demonstrated the following facts which have a direct bearing upon the subject of this paper, and are offered in conclusion.

1. The relative behavior of asphaltic concrete pavements on lean and rich portland cement concrete foundations indicates that no advantage is gained by use of the rich mix. No evidence has been secured to show that the 1:3:6 mix, so commonly used in the past, should not continue to be used for foundations even where subgrade conditions are poor.

2. If heavy traffic is to be expected on the extreme edge of an asphalt pavement constructed on a concrete base, an integral concrete edging should not be used as the load on the edge of the pavement will then be transmitted directly to the base with little or no protection from the asphalt top. For such traffic it would seem desirable to construct asphalt macadam or asphaltic concrete shoulders and carry the original top across the entire width of concrete foundation.

3. Comparison of the relative behavior of the asphaltic concrete and portland cement concrete sections indicates that a 2 or 3-in. asphaltic concrete pavement laid on a lean concrete base 5 ins. or more in thickness has a higher traffic supporting capacity than a rich portland cement concrete pavement of equivalent total thickness.

4. Results from both macadam base and portland cement concrete base sections indicate that the load supporting capacity of a pavement is very materially increased by increasing the thickness of the asphaltic concrete top. This fact should prove an incentive to eastern engineers to investigate thoroughly the possibilities of asphalt base pavements which have proved satisfactory under heavy traffic conditions in the western states.

The foregoing paper by Mr. Hubbard was presented at the Highway Engineering Educational Conference, Clemson College, S. C., March 13, 1924.

HOW TO POUR CONCRETE BRIDGES WITH SPECIAL REFERENCE TO CONSTRUCTION JOINTS

By A. R. Carter, County Superintendent of Highways, Court House, Rockford, Ill.

In discussing this subject I wish to relate briefly a policy we have adopted in Winnebago County in pouring concrete structures. Probably 90 per cent of all concrete structures built in our County are box culverts. I desire, therefore, to give some attention to this particular type.

We specify that in making the excavation, the contractor shall remove sufficient material so that a stable condition of soil adjacent to the excavation shall exist when the bottom of said excavation is at grade and is 2 ft. wider than the outside width of the culvert barrel, such surplus width of excavation to be symmetrical about the center line of said culvert barrel.

After the excavation has been completed, we then require the contractor to frame up the outside lines of the culvert and either have the top of the frame set to the grade of the flow line or by setting in sufficient nails to the proper grade so that there will be no question about

getting the proper thickness of the pavement slab.

If the soil is firm, we do not require any additional width of excavation for the cutoff walls. If, however, there is danger of soil caving, then we require also that the cutoff trenches shall be sheeted. We are also firm believers in the liberal use of tar paper or stone whenever we encounter a wet bottom in which there is any mud or slime, thereby preventing any of this foreign material becoming mixed with the concrete.

In general, we pour a culvert in two operations, and thereby eliminate any exposed construction joints. In the first operation we pour the cutoff walls and the pavement slab. Then, the entire forms are built for the completion of the culvert and the remainder of the concrete is poured during one operation.

The next most important structure is the substructure for slab or girder bridges. Again, as in making the excavation for box culverts, we specify that the coffer dam shall be of such dimensions that at all points there shall be not less than 12 in. left for drainage purposes between the footing lines and the piling of the coffer dam on all sides of it. An exception to this rule is made, of course, when we are positive that no water will be encountered in the coffer dam. In the event that water is encountered, we excavate from 2 to 4 ins. deeper than the bottom of the grade of the footings and then if not much water is encountered, we back fill with coarse stone or gravel to the grade of the bottom of the footing, then cover the entire bottom and sides of the coffer dam with tar paper and thereby conduct the water to the pump pit which is generally located at the end of one of the wings outside of the footing lines. In case there is a large amount of water, it is sometimes necessary to install drain tiles inside of the coffer dam in order to conduct the water to the pump pit. It is very essential to have a pump pit from 12 to 18 ins. deeper than the bottom of the footing lines in order that this method will work successfully and a submerged centrifugal pump is to be preferred over any other type.

The method of placing the concrete in the footings is to begin at the end of the coffer dam farthest from the pump pit and place the first layer of concrete up to the T-bars which usually are placed at 6 ins. from the bottom. Then as soon as the T and N-bars are placed, the next 9 ins. of the footing depth is concreted, then place the Z-bars in the wings, then finish the concreting and place the M-bars immediately afted by pushing the same down into the fresh concrete.

In pouring the remainder of the substructure, care must be used in getting a clean joint between the footing and the abutment wall. This can be accomplished better if in concreting the footing that portion of the footing under the abutment wall is finished a little higher than the remainder of the footing. It is also a good idea to leave an opening at the ends of either wing so that any foreign material may be thoroughly washed out before concreting. In order that we may be insured of getting a good joint, we usually require the contractor to leave out a portion of the stone in each batch until we have sufficient concrete placed on the bottom so that we will be able thoroughly to spade and take care of the coarse aggregate.

Whenever possible we desire to pour all of the concrete in the abutment wall in one operation, thus eliminating all construction joints except at the junction with the footing. If this is not possible, then we prefer to make a construction joint below low water level and then complete the remainder of the abutment in one operation. In any event, do not permit a construction joint at an elevation of less than 18 ins. below the elevation of the end of the lowest wing.

The concrete should be placed in horizontal layers of not more than 12 ins. at a time and thoroughly spaded to bring the mortar in thorough contact with the forms and reinforcing steel.

When it is necessary to make a construction joint in a wall, the concrete should be stopped as nearly as possible in a horizontal plane and within one hour after the last concrete is deposited, the entire top surface of the concrete down to the coarse aggregate shall be removed, and before concreting is resumed, the loose material shall be washed away and the surface thoroughly wetted and flushed with a thin mortar consisting of one part of cement and two parts of sand.

In concreting superstructures, if possible, all concrete in any slab, girder or arch shall be poured continuously. In the case of arches, concreting shall begin at the springing lines and shall be carried along from both springing lines symmetrically toward the crown. If joints in floor slabs are necessary, they shall be made in vertical planes located perpendicular to the main reinforcing steel and

near the middle of the slab span, except for concrete floors on steel bridge, in which case the joint shall be vertical, at right angles to the axis of the roadway and over the center of the floor beam.

Construction joints in arches shall be at right angles to the main reinforcing steel and the axis of the arch. When more than two runs are required to pour the arch, the concrete shall be poured in alternate blocks extending across the entire width of the arch to insure uniform settlement of the false work.

When it becomes necssary to cease concreting for a period of 24 hours or more and when there are no reinforcing rods protruding, grooves should be formed in the top surface of the concrete by embedding timbers. When concreting is resumed, these timbers should be removed and the entire surface of the concrete cleaned and flushed as indicated above. As an alternative, "one-man" stones embedded one-half their thickness, may be substituted for the formation of grooves. This latter construction would take place in piers or in gravity sections of retaining walls.

The foregoing paper was presented at the recent Short Course in Highway Engineering conducted at the University of Illinois, Urbana.

BIDDING AND BONDING OF PROFESSIONAL ENGINEERS

Practice Case No. 45 has been submitted by the National Practice Committee to the Board of Directors of the American Association of Engineers for approval at its next meeting. This will be held in connection with the annual convention of A. A. E. at San Francisco, June 11-13, 1924. The case is of fundamental importance to the profession and particularly to practicing engineers.

The Case and Comment

Several instances have recently been reported of cities inviting engineers, by letter or advertisement,

(a) To submit competitive bids or sealed proposals for furnishing specified engineering services.

(b) To furnish, with their bids, bonds for the satisfactory performance of their services.

(c) To furnish, with their bids, a guarantee that the cost of construction will not exceed their estimates.

Q. 1. Are any principles of good professional conduct violated by engineers tendering their services under the terms outlined?

Answer 1. (a) For engineers to submit competitive bids or sealed proposals for furnishing specified engineering services is not consistent with the highest professional standards. Competition between engineers for professional work should be minimized; it should be countenanced, if at all, only in those cases where professional qualifications are clearly the paramount consideration and the question of relative fees is not a deciding factor. To make professional work a matter of money competition not only lowers the standards of the profession, but is detrimental to the interests of the public. It may be viewed as a violation of the "Specific Principles of Good Professional Conduct," Part 4, Clause 8.

(b) and (c) The requirement for engineers to furnish bonds for the satisfactory performance of their services or to furnish a guarantee that the cost of construction will not exceed their estimate, should not be tolerated. Such requirements are incompatible with a sound and conscientious professional attitude of the engineer toward his client and his work, and unavoidably conflict with proper discharge of the engineer's obligations to his clients. The public should be educated to a proper conception of the *professional attitude* which gives its best in service or expert advice without influence or prejudice by fear of penalty or hope of reward.

Q. 2. Formulate principles to cover the proper conduct of engineers with regard to such conditions.

Answer 2. The following statement of principle covers the proper conduct of the engineer with regard to the conditions above discussed:

He should maintain the professional attitude in negotiations for his services, and should decline to submit competitive bids for professional services, to furnish bonds for satisfactory performance, or to guarantee estimates.

It is recommended that this statement of principle be inserted in the place of the canceled Clause 8 of Part 1 of the "Specific Principles of Good Professional Conduct."

THE LARGEST HYDRO-ELECTRIC PLANT IN THE WEST PLACED IN SERVICE

The first unit of the largest hydro-electric generating station in the West, the Big Creek No. 3 plant of the Southern California Edison Co., has been placed in operation. This is the fourth power house on the Company's Big Creek and San Joaquin project, which, when completed, will include about 10 generating stations with a combined capacity of over a million horsepower. The power from Big Creek No. 3 is being spread over the entire system of the company, which serves some three hundred cities, towns and rural communities, including the City of Los Angeles.

The Big Creek No. 3 power house consists of two main structures—a concrete building which houses the turbines, generators and control switchboard, and a 220-kv. outdoor switchrack, which covers an area of 80,000 sq. ft. The present installation consists of three 35,000-h.p. vertical turbines, built by the Wellman-Seaver-Morgan Co. and three Westinghouse 28,000 Kv-a. generators. The turbines operate at a speed of 428 revolutions a minute under an effective head of 740 ft. Each turbine is equipped with Woodward governors which are controlled from the switchboard. The generators have exciters directly connected to the top. Power is generated at 11,000 volts and is stepped up to 220 kv., through seven 18-500 kv-a. Westinghouse transformers located on a large platform just outside the building.

Electrical Equipment

The electrical equipment is rather out of the ordinary in that, while it is built on the unit principle, it goes a step further and instead of a single generating unit with its bank of transformers, there are installed two generators to each bank of transformers, and this group constitutes a unit. The reasons for this arrangement are the elimination of generator buses and the reduction in number of the high tension switching equipment. This scheme also allows the advantage of purchasing transformers at a lower unit cost.

VIEW FROM TOP OF PENSTOCK SHOWING POWER HOUSE, 220,000-VOLT CIRCUIT BREAKER INSTALLATION AND CONSTRUCTION CAMP IN BACKGROUND.

The Railway Incline to the Power House Can Also Be Seen. This is the Longest Cable Incline in the World and Has at Places a Grade of 70 per cent. The River is the San Joaquin.

At present there are installed three generators and two banks of transformers. The ultimate extension will necessitate the purchase of another generator for No. 2 bank of transformers and the duplication of No. 1 unit.

Another novel feature of design is the elimination of the basement in the generating room. The operating floor is on two levels—one at the base of the generator and the other at the elevation of the turbine, so that practically all equipment is in view of the operator at all times.

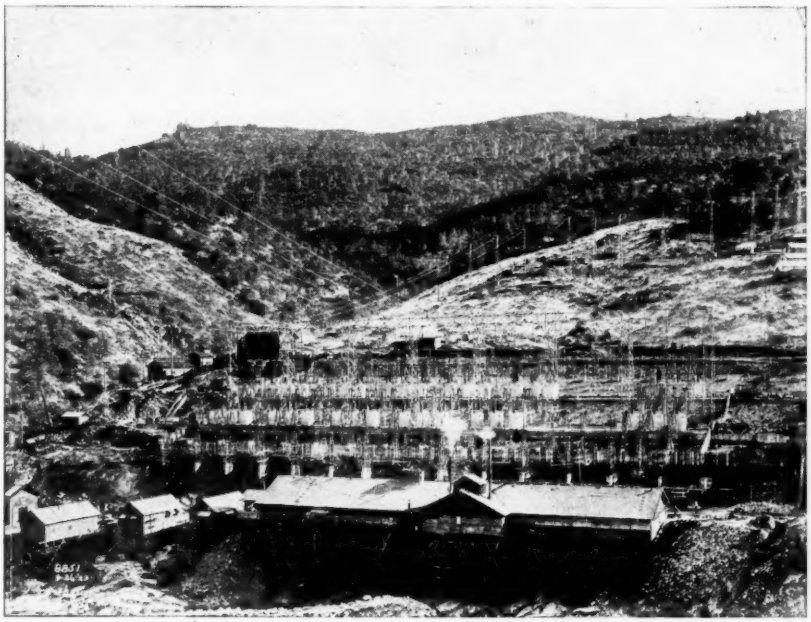
Lubricating System Simplified

One of the important improvements thta has been adopted is the elimination of the exterior lubricating oil system, consisting of filters, supply tanks, pumps, piping, etc. It is felt that much more reliable operation may be had by simplifying the lubricating oil system to the greatest extent. To this end the bearing on the water wheel and the generator bearings are provided with gear-driven oil pumps, which will pump the lubricating oil from a small pump below the bearings to the top of the bearings and thus keep the oil circulating continuously. Motor-driven pumps are also installed for supplying oil on the starting up of the unit and are arranged to be started automatically in case a gear-driven pump should cease to operate.

Protective Measures

The generators and transformers are protected by relays differentially connected so that in case of insulation failure the apparatus in trouble will be disconnected from the system with a minimum amount of damage to the windings or the laminations. The connections are so made that whenever possible the 220-kv. oil circuit breakers will rupture the current at the time of trouble, the generator breakers functioning only in case of trouble in the generator. If, on the other hand, a transformer should fail or a transformer lead should become grounded anywhere between the 200-kv. rack and the current transformer on the low side of the transformers, then the differentially connected relays will function, opening the 220-kv. oil circuit breakers and the generator breakers, thus cutting the transformer off the 220-kv. bus. After the oil circuit breakers open, the fields of the generators are opened and the wicket gates of the turbines are closed, thus closing down both generators.

Arc suppressors are now being installed, their purpose being to automatically lower and raise the voltage on the

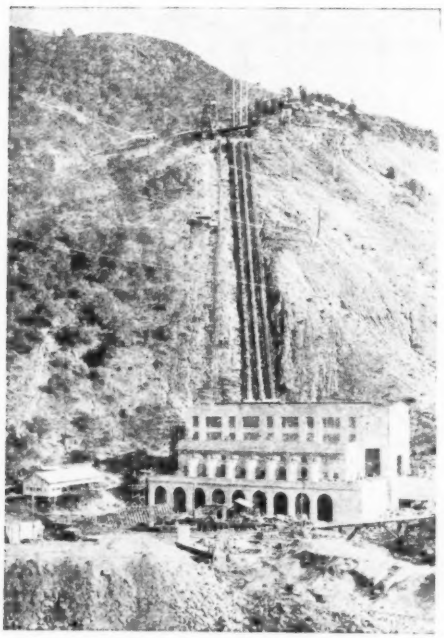


INSTALLATION OF TWELVE 220,000-VOLT ELECTRICALLY OPERATED OIL CIRCUIT BREAKERS.

generators in case of a flashover or ground on the transmission line.

The Power House

The power house building is large enough for four generators. When extended it will accommodate an additional bank of transformers and two more generators. The 220-kv. switch rack is large enough to accommodate the ultimate capacity of the plant and two additional lines besides the present Big Creek main lines that now loop through at this point. At present there are installed four line positions and two transformer positions, making a total of twelve 220-kv. oil circuit breakers. These are all controlled from the main switchboard, a distance of approximately 900 ft. In addition to the control there are indicating lamps giving the operator a red light when an oil circuit breaker is closed and a green light when it is open. All the electrical equipment, including the transformers, switching apparatus, etc., was supplied by the Westinghouse Electric and Manufacturing Co.



BIG CREEK NO. 3 POWER HOUSE SHOWING PENSTOCKS UNDER CONSTRUCTION.

The Big Creek No. 3 station is located at the confluence of Mill Creek and the San Joaquin River, about six miles below Big Creek No. 8, and uses all of the available water of the San Joaquin River plus the amount that is released from Huntington Lake through Big Creek Nos. 1, 2 and 8. The diversion dam, called Dam No. 6, is located just below the tail-race of Big Creek No. 8 on the San Joaquin River. It is 150 ft. high and 485 ft. long, and has a storage capacity of 1,040 acre-ft., measured to the bottom of the tunnel. The water stored here is sufficient to carry the present capacity of Big Creek No. 3 at full load for 7¾ hours.

The Dam

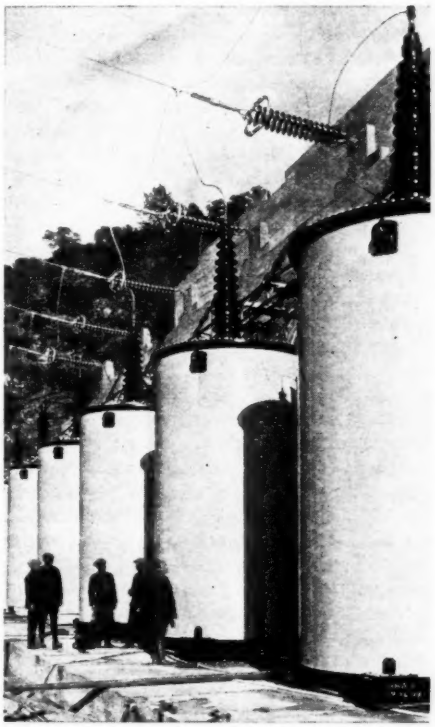
In the dam are installed four 7-ft. square sluice gates, having a combined discharge capacity of 3,000 sec. ft. The intake of the tunnel consists of a reinforced concrete structure 115 ft. high in which is installed a cylindrical gate 22 ft. in diameter and 90 ft. high. This gate is motor operated, and controls the water going into the tunnel. It is hydraulically balanced and therefore uses a minimum amount of power. There is a 21-ft. tunnel leading from the intake of the diversion dam, which is 30,000 ft. long and has a grade of 3 ft. per thousand. This tunnel is excavated from solid granite and has a capacity of 3,000 sec. ft. The road from the intake to power house No. 3 was excavated out of solid granite and traverses the grand canyon of the San Joaquin River. Portions of this road cost as high as $200,000 per mile. There is an incline 7,200 ft. long leading from the San Joaquin & Eastern Railroad down to the power house site. This incline has the longest continuous cable in the world, three miles in length without a single splice.

Surge Chamber

A surge chamber is constructed at the lower end of the tunnel which reaches a height of 200 ft. above the tunnel floor. This surge chamber is excavated from solid rock and has an hour glass section, the bottom diameter being 60 ft., the central shaft 25 ft. and the top diameter 75 ft. This hour glass section was adopted on account of the wide variation in the water level at the intake under normal operating conditions. The large section at the bottom provides for a load suddenly applied and the large section at the top will take care of any surge created by loads rejected.

Manifold

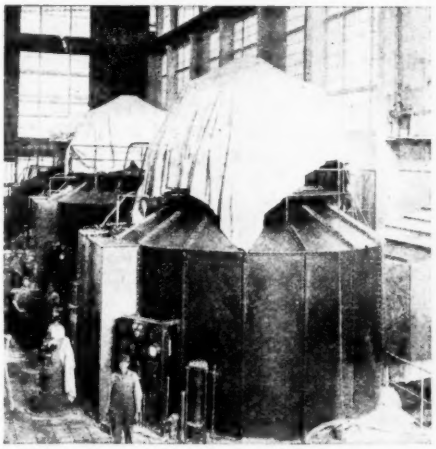
Connecting to the outlet of the tunnel is an 18-ft. steel pipe which terminates in a manifold providing connections for six penstocks. The design of this manifold, which will operate under a total head of approximately 200 ft., offered many difficulties. After much study a design was finally developed which consists of two plate steel spheres ⅝ in. in thickness, joined by a short section of pipe. To one of these spheres the 18-ft. pipe and two of the penstocks connect, the other sphere providing connections for four penstocks. The adoption of this type of manifold permits taking care of the excessive stresses in a very simple manner and has successfully solved a very difficult problem. At present there are only three penstocks attached to the manifold, as the capacity of the plant is only one-half of the ultimate development. Each penstock is 7/16 in. thick and 7½ ft. in diameter at the top and at the bottom is 1¼ ins. thick and 6 ft. in diameter.



CLOSE-UP VIEW OF THE SEVEN 18,500 KV-A, 220,000 VOLT OIWC WESTINGHOUSE TRANSFORMERS INSTALLED ON PLATFORM OUTSIDE POWER HOUSE.

Penstock

Several novel features have been incorporated in the penstocks for this new power plant. The entire pipe line will be of forge welded steel; as the pipes are to be installed above ground, expansion joints are used between anchors. These expansion joints are made so that a portion of the pipe on which the packing bears is copperplated to a thickness of about 1/16 in. This will provide a perfectly smooth and non-rusting surface for the packing and it is expected that all future trouble due to leakage will be eliminated.



THREE WESTINGHOUSE 28,000-KV-A, VERTICAL GENERATORS

View Shows External Ventilating Housing by Which the Air is Drawn Through a Humidifier and Expelled Outside the Building. Instillation Incomplete.

In pipe lines of this sort the friction of the supporting piers makes necessary extremely heavy anchors at the bends. In order to reduce the size of the anchors to relieve the pipe of excessive longitudinal stress, and also to facilitate erection, these pipes will be installed on cast iron rockers. Tests have shown that the friction will be reduced so greatly that a very large saving can be made in the cost of anchors and supporting piers. These rockers will be installed every 40 ft. instead of 20 ft. as has been the custom heretofore in ordinary piers.

BIDDER'S BOND VS. CERTIFIED CHECKS AT HIGHWAY LETTINGS

By A. E. Horst, Secretary of Henry W. Horst Co., Rock Island, Ill.

As a means of guarding the integrity of a bid, especially in public lettings, the bidder's bond and certified check have their advantages and weaknesses. Being based on human judgment, neither serves perfectly its purpose, because both are intended to underwrite accurately the hazards with a view to reducing responsibility of the owners, whether state, municipal, or otherwise, to a minimum.

Purpose of Bid Bonds and Checks

It is intended that a bid bond or a certified check attached to a bid be a guarantee to the parties receiving this bid that the contractor will enter into a contract and fulfill all of the requirements of the plans and specifications upon which his bid is made. A bid bond or certified check attached to such a proposal, to be worth anything, therefore, must be a bona fide guarantee that the contractor will enter such a contract. It also reverts itself into a penalty upon the contractor if his bid is accepted and he does not enter into contract, the penalty being the amount of the certified check or bid bond. If either the bid bond or certified check does not accomplish the above purpose purpose it is worthless.

Use of Bid Bonds Decreasing

In many instances laws are such that they permit a bid bond to be attached to a proposal, but due to technicalities which are not easily discovered, if the contract were awarded to an exceptionally low bidder the bid bond might not be of any value whatsoever. For this reason the use of bid bonds seems to be on the wane in many states and localities. It appears, as above stated, that these bid bonds are and have been issued by underwriters without carrying any obligation on any of them to bond the bidder in case he is successful. Under these conditions the bid bond would appear to be worse than useless, and for that reason should be eliminated in all such localities where this is the case. This type of bid bond was formerly in effect in New York, but was dispensed with there some years ago.

Since much, in a general way, could be said about the questionable value of bid bonds of this type compared to certified checks the speaker believes that for the purpose of this discussion, which is to apply specifically to highway lettings in Illinois, we should assume that a certified check and a bid bond, so far as the penalty is concerned if the contract is not entered into, are on an equal basis and both have the same face value in this respect.

Advantages of Bid Bonds

Some of the advantages in submitting bid bonds with proposals at highway lettings are,—that no interest needs to be paid on amount of bid bond, nor are contractors' funds tied up if exceptional delays are caused in awarding contract, whereas, the use of certified check requires that the contractor must decide several days in advance just which projects he will bid. The amount of his bid on each of these projects must also be determined in order that he may secure the proper amount and number of certified checks for each project, and see that these certified checks are properly delivered to the place where the letting is to be held. This is, of course, exceedingly difficult especially at times when bidding work several states distant from one's home office.

It has seemed to the speaker that where certified checks are required at highway lettings there are apparently a lesser number of bids submitted than where bid bonds are in use, but still ample competition. It has also seemed that where bid bonds are permitted in lieu of certified checks bids are submitted by many who have not had the experience or have the capital or equipment to warrant them bidding on the large projects they do.

When we analyze the procedure in securing certified checks and the procedure in securing bid bonds we find, in the one case, it is necessary for the contractor to secure certified checks from a banking institution, in the other, from some representative of a bonding company. In order to secure, say a $50,000 guarantee, it is the speaker's judgment that it requires much more preparation, deliberation, explanation and backing to secure certified checks totaling this amount from some one of the many representatives of bonding companies, especially when there are so many bonding company representatives who have the authority to give out these bid bonds.

Superior Advantages of Certified Checks

In a given community there probably are five or six banks that might be willing to give a contractor certified checks totaling $50,000. In this same community there probably are three times as many

representatives of bonding companies who would have authority to give bid bonds for much larger amounts if they so desired, so that the chances of an irresponsible contractor securing a bid bond in this community in lieu of a certified check is at least three to one, since only the judgment of the representative of the bonding company is involved and his judgment might be influenced because he is paid a substantial commission on the performance bond premium; whereas in the case of the bank, the cashier or president authorizing the certified check secures but the regular rate of interest which goes not to his personal benefit, but to the institution which he represents. In other words, the representative of the bonding company is interested in making a bid bond because he personally secures a substantial commission for doing so if the contractor secures the award, whereas the banker personally secures nothing in return. It is, therefore not difficult to understand that the bank is going to be mighty sure that the contractor is in proper shape to handle the work before giving him a certified check, while the bond agent will endeavor to write as many bid bonds as possible at a letting in order to increase his chances for securing for himself personally the commissions derived from a successful award. Most bid bonds are written the day of the letting when not as much consideration of the actual facts can be given as when certified checks are arranged for in a very deliberate way days in advance of a letting.

Promiscuous Writing of Bid Bonds

It is common knowledge that at some of the highway lettings there were many bid bonds written for contractors that were not even reported to the bonding companies' executive offices by agents writing them, indicating to what extent these practices have gone in the promiscuous writing of bid bonds by representatives of the bonding companies who happened to have the blank forms to execute. It is also known that some contractors have been given blank forms of bid bonds to fill out for any amount they saw fit.

Too Much Irresponsibility

The speaker recognizes the fact that there have been altogether too many irresponsible representatives of bonding companies writing bid bonds for irresponsible contractors and that the executives of some of the better class of bonding companies do not mean that this practice shall prevail, nevertheless, it does prevail, and until it is eliminated certified checks, which are not given out without serious consideration, seem to be a better guarantee and indicate that the contractor using them has used due diligence, and is properly qualified for the work.

Another advantage to the contractor in the use of a certified check is that he may select which bonding company he may wish to place the performance bond with when awarded the contract which he may not be in a position to do before his bid is submitted. He also may elect, if it is permissible, to place personal collateral as a means of good faith in performing the contract rather than a surety company bond which may be less expensive to the owner and quite as effective as a surety company performance bond.

In general, therefore, the opponents of the bid bond cite the wholesale and promiscuous distribution of blank forms by surety companies' agents which, as above indicated, apparently throws the gates open to any one who can tabulate figures. It is held that a great number of irresponsible companies, who know nothing of estimating, and perhaps less about contractors' managing and financing, and who have no financial backing, are able to submit proposals. Once these proposals are submitted the bidder secures a surety bond, which he invariably can, and the state is obliged in most cases to award him the contract. Upon the heels of this action follows the whole gamut of dissension and evasion and improper performance on the part of irresponsible companies who bring suspicion upon all contractors and keep public construction in a state of demoralization.

Abolish Bid Bonds

The speaker believes that the abolition of bid bonds at highway lettings would not be discouraged by the reliable and conservative bonding companies, thereby permitting certified checks to be used under all circumstances. In fact, several representative men of such bonding companies have encouraged the use of certified checks. What has begotten the call for the bid bond has been chiefly the fact that many states and municipalities have taken a bunch of bids under advisement for a month or longer, in which case a large certified check outstanding would be quite a large tax on the contractor. On the other hand, if there were a uniform practice of return

ing certified checks immediately after a few days consideration of the bids, except the successful bidder's who in the meantime has qualified with the proper bond, the objections to the use of a certified check would not be great. There should be no objection and no hardship on the state—if the low bids are taken under advisement for more than several days—to permit the contractor to replace his certified check with any other good and equal security until award or rejection of his bid, in order to permit the use of funds involved in the certified check.

It is my opinion if certified checks—and certified checks only—were required at highway lettings, and the amount of the certified check be somewhere between 7½ and 10 per cent of the bid, that the tendency would be to secure bids only from contractors who are responsible to carry out the work upon the basis of their proposals, and in accordance with plans, specifications, and time of completion. Contractors would be much more careful in building up their proposals, due to the fact that their own perfectly good certified check worth that much of their own cold cash, which they alone are responsible for, could be held as liquidated damages if their bid were accepted and they refused to enter into contract.

The foregoing paper by Mr. Horst was read at the recent Road School conducted at the University of Illinois at Urbana.

HOW A COMMITTEE OF CITIZENS CAN SECURE SUPPORT FOR CITY PLANNING PROGRAM

By John Nolen, Town and City Planner, Harvard Square, Cambridge, Mass.

What is the weakest link in the city planning chain? Is it not the general lack of understanding by the public of what city planning is, its purpose, its method, its advantages, its cost, its justification? And is not this lack of understanding due largely, if not mainly, to the lack of effective publicity?

If the answer to these questions is in the affirmative, what is the place of citizens' committees in securing support or backing for city planning in its various stages?

It might be well to recall that many of the official functions of cities today began as private endeavor, and have now become a part of the work of the regular city government. Examples might be given in the various movements for parks, playgrounds, public health and hygiene, libraries and museums—in fact, almost every municipal activity that has to do with welfare work of a public nature. We all know that city planning can properly be added to this list.

Examples of Work Accomplished by Citizens' Committees

The main purpose of this paper is to discuss the place of citizens' committees in a city planning program. This is on the assumption that it is a well recognized fact that city planning projects themselves must, with rare exception, wait for execution upon public authorities and public action.

The citizens' committees, however, can render services that may be conveniently put down under three heads. In the first place they can continue to do for city planning what they have done for other subjects for many decades—they can initiate city planning work before its value is appreciated by the general public, which means usually, also, by the city government. Secondly, a citizens' committee can guide city planning, once a program has been made, by keeping proposals before the public in cases where through a shift in the personnel of a city government or for other reasons plans of merit may be lost sight of. Third, citizens' committees can render a service in helping a city government "put across," as the phrase goes, projects approved by the city government involving bond issues, special appropriations or the passing of ordinances, as in the case of zoning.

Citizens' committees are often in a better position for publicity work than official commissions, because of funds at their disposal or the greater freedom and initiative which they have. Among the best examples of the work of so-called citizens' committees may be mentioned the following: Akron (Ohio), Buffalo, Chicago, Cincinnati, Cleveland, Cohasset (Mass.), Dallas, Elkhart (Ind.), Erie (Pa.), Johnstown (Pa.), Los Angeles, Madison (Wis.), Minneapolis, Pasadena, Pittsburgh, San Diego, St. Louis, St. Paul, Walpole (Mass.), Worcester.

In all these places, and many others, citizens' organizations of some sort, as distinguished from official bodies, were important factors in promoting city planning. But these organizations were different in character. In many cases they were simply a committee of the cham-

ber of commerce or other regularly constituted commercial bodies. In others they were citizens' organizations of various forms, definitely organized to work for city planning.

In Akron the city planning work was guided by the Chamber of Commerce, but I have no detail information as to methods employed and results. In Cohasset, a very small Massachusetts town, the initiative was taken by a local Men's Club, and the work of planning and carrying out civic improvements, amounting in all to more than $100,000, was paid for by private subscriptions. The improvement work in Walpole, another Massachusetts town, was initiated and directed by the Walpole Community Federation. Its object was to league the officers and committees and existing organizations in the town of Walpole in a community organization as a clearing house through which, with the united assistance of the community, plans and programs may be prepared to further the progress of the town. Walpole, perhaps more than any other small community of 5,000 population, has a long list of town planning improvements to its credit, which have been admirably summarized in charts and lists in a volume entitled "Town Planning for Small Communities," published in the National Municipal League Series.

Madison, Wis., began its city planning work by utilizing the Park and Pleasure Drive Association, a voluntary citizens' association, privately supported and conducted through a long period of years for the acquisition, planning, development and maintenance of public parks. This association undertook the preparation of a comprehensive city plan and report, which were presented to the city government. It is difficult to say how much influence city planning studies of this sort have upon the policy of a city. There can be no doubt, however, that they are one of the best forms of publicity, and provide a city planning program for local educational work of a more definite character than can be secured through the more theoretical and abstract arguments for city planning in general.

Cleveland

Cleveland was one of the earliest to move in city planning, and action was taken by the Chamber of Commerce. The first committee was on the grouping of public buildings in 1899. Since that year the Cleveland Chamber of Commerce has inaugurated and backed city planning enterprises dealing with the union station and other railroad facilities, river and harbor improvement, bridges, housing, parks, street changes, museums and many other matters of a city planning character. A recent report on city planning for Cleveland by the Chamber of Commerce proposes the formation of an association, the purposes of which would be—

1. Organization: The charter members of the association should be the civic and professional organizations called to the initial meeting by the Chamber of Commerce.

2. Purposes: The purpose of the association might be—

(1) To promote knowledge of and interest in a comprehensive plan for Cleveland.

(2) To raise the fund for correlating and completing such a plan.

(3) To publish the plan.

(4) To be the organ of contact between the official commission and the Cleveland public.

(3) Membership: There should be three classes of membership, active, auxiliary and supporting.

In addition to the Cleveland city planning projects undertaken by the Chamber of Commerce, many studies and reports were made by city and county authorities and by civic organizations other than the Chamber of Commerce. They include studies of the growth of the metropolitan area of Cleveland, transportation, bridges, parks, and studies of finance and legislation.

Chicago

The plan of Chicago was presented to the City of Chicago by the Commercial Club of Chicago. Afterwards the Chicago Plan Commission was created, the appointments being made by the Mayor, the Commission having advisory but not executive powers. Many of the members of the Commercial Club were appointed on the Plan Commission, which included the aldermen and all heads of city departments. Other members chosen from every section of the city and from every walk of life made up a total of 328 members of the Plan Commission. The cost of the Chicago Plan has been set down as $85,000, which covered the publication of the original report. The Commercial Club expended in addition over $50,000 to maintain its technical staff and provided during a decade a total of over $300,000 on account of the Chicago Plan.

The record of Chicago's campaign for

city planning under the leadership of the Commercial Club is extensive. A brief summary follows:

1. The printing of the "Chicago Plan" report already referred to.

2. Publication of the booklet entitled, "Chicago's Greatest Issue—An Official Plan," of which 165,000 copies were issued, one being delivered to every property owner of the city and to persons paying a rental of $25 per month or over.

3. A notable pamphlet entitled, "Fifty Millions for Nothing," dealing with the lake front.

4. Other special pamphlets and reports, ending with the publication entitled, "Chicago's World-Wide Influence in City Planning."

5. Combined effort on the part of the newspapers and the pulpit, based upon the Commission's publication entitled, "Seed Thoughts for Sermons."

6. A school textbook entitled, "Wacker's Manual of the Plan of Chicago," of which more than 50,000 copies have been published.

7. A lecture bureau. It is estimated that 175,000 people have been directly reached by lectures, which is one in every fourteen residents of Chicago.

8. A motion picture campaign, consisting of a two-reel feature entitled, "A Tale of One City," shown to audiences of more than 150,000 people. The opening was at the Majestic Theatre to an audience which packed the house to capacity, and was as representative as a Grand Opera occasion.

9. The Chicago daily press. Publishers, editors, reporters, cartoonists and feature writers cooperated effectively and generously to carry the message of Chicago's Plan to the people.

10. The publication by Walter D. Moody of a volume of 430 pages entitled, "What of the City?—America's Greatest Issue—What It Is and How to Go About It to Achieve Success."

Dallas

In 1902 the Civic Improvement League of Dallas was formed under the leadership of George B. Dealey of the Dallas Morning News, with the direct cooperation of the American Civic Association. In 1909 the Dallas News published a series of letters outlining the important features of city planning for Dallas. These letters were clipped and sent through the mail to a selected list of leading citizens. Beginning in 1910 the Dallas News carried on a campaign for suggestions as to the most important civic work Dallas should undertake during the year. Through this activity civic improvement became the talk of the day. Later, in 1918, the Dallas Property Owners' Association was organized, also a voluntary body financed by private subscription.

As a result of these various activities a union terminal passenger station was built, grade crossings eliminated, and land acquired for parks, playgrounds and boulevards and other improvements of a city planning nature. In 1919 the Metropolitan Development Association was formed and a City Plan Commission established by a charter amendment. There is now a City Plan Engineer, but up to 1922 his salary was paid, not by the official City Plan Commission, but by a citizens' group. The city government now has an annual budget of $8,000 employing a City Plan Engineer, a draftsman and a stenographer.

Cincinnati

The United City Planning Committee of Cincinnati was formed in 1915 for the purpose of starting a city planning movement in Cincinnati. At that time there was no interest in the subject whatever. The Committee consisted of delegates or representatives of a few existing general civic organizations such as the City Club, Chamber of Commerce, etc. The first step was to obtain state legislation. During the war the Committee was inactive, but the work was revived in 1919. The Committee started out with representatives of 6 organizations, but now includes over 30. Each organization names its own delegates, and as many as it pleases, but with only one vote on a division. There has never been a division. Membership includes all civic organizations and all professional organizations relating to the subject, such as realtors, engineers, architects, etc. The constitution specifies three purposes.

First: To conduct an educational campaign.

Second: To raise funds.

Third: To be organ of contact between the public and commission.

The Committee agreed from the beginning that its work should be for a comprehensive city plan—nothing less, nothing more, nothing else. Also that it should be an official plan, and therefore that the fund, except for incidental expenses, was to be turned over to the official Commission.

The United City Planning Committee of Cincinnati has raised over $100,000,

and transmitted over $90,000 to the official Commission. The original idea was that the unofficial Committee should raise $70,000 and the City would contribute $30,000. So far, I understand, the City has contributed nothing. There have been over 5,000 contributors ranging from $1 to $15,000. The educational function of the unofficial Committee has been constantly performed through leaflets, postals, telegraph messages, press publicity—always "ding donging" on what the city plan is, what it includes and what it means for the city. The words "city plan" now represent something worth while in Cincinnati, and nearly everybody is familiar with the expression, and nobody thinks of proposing a new public improvement without ascertaining its relationship to the city plan. In general the unofficial Committee has taken no stand for or against any city improvement, but adheres closely to the proposition of having a city plan. A special feature in the method of raising the money for the city planning work in Cincinnati was the inclusion of it in the Cincinnati Community Chest, contributions, however, to be only as "specially designated." Nearly all the collections were made by this method.

Pittsburgh

City planning for Pittsburgh began in 1910 when the Pittsburgh Civic Commission, under the leadership of H. D. W. English, financed the making of a number of studies. The most important of these was the report of Pittsburgh, Thoroughfares and the Downtown District. Shortly after this, in 1911, Mayor W. A. Magee secured the passage of acts of Assembly giving the city two new departments of government—the Department of City Planning and the Art Commission. Then followed a period of seemingly fruitless struggle to replace haphazard methods by a more orderly procedure.

The Citizens' Committee on a City Plan for Pittsburgh was organized in 1918 with nine directors. Its purpose was to prepare comprehensive plans for future development. The Committee has no official status, is self-created and self-perpetuating. The qualification for membership is subscription to the funds of the association. In the beginning it included only about 20 members, but has now over 200 individuals and corporations. Subscriptions range from $100 to $20,000, and it is estimated that it has completed work which cost in the neighborhood of $250,000. This fund goes entirely into the making of studies and plans, the publishing of reports and the educational campaign. Of this sum $40,000 was spent for the basic maps. Three preliminary reports, street plan, playgrounds and zoning cost approximately $4,000. Meetings, dinners, etc., cost $2,500, which was virtually underwritten by individual subscriptions. Special separate reports as a part of the Pittsburgh Plan have been issued covering transit, parks and waterways.

Johnstown, Pa.

The two striking features of the educational work in behalf of city planning in Johnstown are: First, that it was carried on by the City Planning Commission itself—really through the initiative and energy of its Secretary, Mr. L. J. Buettner—and, secondly, the interest that was aroused through the children in the public schools. The challenge went forth on the part of the children to the taxpayers and the officials of the municipal government that, "If you don't grasp the opportunity to improve Johnstown and give it the place it deserves among cities of the country, we will." Boys and girls of the grammar grades afforded convincing arguments for adopting the Planning Commission's Report. Pupils presented illustrated lectures urging civic improvement, and the discussion of city planning was one of the leading features at the graduating exercises of the high school classes. Public addresses were made by the children on such subjects as "The City as a Whole," "Thoroughfares," "Rivers and Bridges," "Parks and Playgrounds," "Municipal Buildings." The liberal cooperation of local newspapers including the reproduction of plans and sketches, is also worthy of special mention.

The Secretary of the Commission states that as a result of their publicity of city planning matters the people of Johnstown do not ask, "What are you going to do," but, "When are you going to make these improvements."

Buffalo

One of the most encouraging, in fact inspiring, illustrations of what a citizens' committee can do is the case of Buffalo, where an association of citizens known as the Buffalo City Planning Association, Inc., was organized to present city planning to the public. This association doubted whether the official City Planning Committee could ask the people to pay their money to give publicity to a plan to spend more of their money, so

these citizens undertook to make the plan public at their own expense having first obtained the approval of the City Council.

The best account of the work of this association is that of C. J. Hamlin, the President, which is given here in slightly abbreviated form. "The Association was interested in bringing in the best of the element in favor of the plan. We held a meeting. We invited the president of the Rotary Club, the Chamber of Commerce, the Greater Buffalo Ad Club, and other clubs and some prominent citizens to this meeting and, not having a plan so beautifully drawn as here, we explained to them the plan and wondered how it would be received. We were delighted when they applauded.

"After that we held many such meetings and invited small groups to see the plans before they were made public. They were complimented by the invitation and, one after another, we interested these influential groups of citizens. Up to this time there was no publicity, no newspaper notices.

"Finally, we were ready for publicity. We secured 30 signatures for a guarantee of $1,000 each to finance our publicity. We could not have secured this otherwise as no one knew about it except these prominent citizens.

"Next a very careful mailing list was prepared. It listed 200 organizations in the city. We wrote them that we would like ten names to send our literature to, for of course, as you know, there are about ten people in every organization who run it, and these were the people who got on our list—the people who do the talking. We went to the Democrats and the Republicans, and finally had about 14,000 names. We got an addressing machine so that we could address the mailing list over night.

"We had a dinner for the newspapers, told them our whole plan and arranged with them to release our publicity. They alternated our stories between the Sunday and daily papers, that is, between the morning and evening papers—and there was city planning all over the place.

"We sent out, under a one cent stamp, our Bulletin No. 1—"Get Behind Buffalo Today." You open it and you see Buffalo of today. You open it a little further and you see Buffalo of tomorrow. This was just a preliminary statement sent to the public.

"We showed, in our next Bulletin, the circuit traffic way on a map of the city of Buffalo and enumerated the organizations in favor of it.

"Another publicity idea was to offer $100 in cash for the best name for the proposed circuit traffic way and we had 1329 different names submitted with many more, counting duplicates. You know how it is. Your boy gets interested and he gets father to help him find a name, and father, in hunting for a name, gets sold on the proposition. The name finally chosen was "The Concourse—a meeting place of peoples."

St. Louis

In view of the recent approval in St. Louis of a bond issue of over $80,000,000 for city planning projects, the history of city planning effort in that city is of special interest and value. The citizens of St. Louis made many city planning endeavors from 1906 to 1915, none of which produced results. These included the appointment of a City Plan Commission in 1912, which failed to understand its problem and devoted most of its time to the development of a parkway project which was lost at a special election, following which the City Plan Commission resigned in a body. It has been estimated that more than $100,000 was expended in various ways during this decade that produced no tangible results, except, perhaps, from the standpoint of indirect public education.

The Citizens' City Plan Committee of St. Louis came into being following the resignation of the members of the City Plan Commission in 1915. They had a proper conception of beginning by planning comprehensively. They also raised funds with which to initiate city planning work of a technical character and kept public interest alive. Tribute should be paid here to Luther Ely Smith, long the Chairman of the St. Louis Citizens' Committee, and its main source of inspiration, and also to Harland Bartholomew, who became City Plan Engineer in 1916, when a definite program of work was adopted. Mr. Bartholomew states that he "believes a citizens' committee should be a continuous body if it is possible to keep it alive, and that its function should be continually to promote the city plan and to prevent its violation for political or other reasons." A significant phase of the city planning work in St. Louis is that the City Plan Commission has no authority whatsoever, is created and acts under what would now be considered a wholly inadequate ordinance. The re-

sults have been obtained by careful, continuous educational work and diligent, unselfish attention by the members of the Commission who serve without pay, and by the excellent support and cooperation of the municipal administration and the mayor. The office force consists of one engineer, one architect, a secretary, a stenographer, two draftsmen and an office boy.

Conclusions

What conclusions, then, may one draw from these selected records of the work of citizens' committees?

1. That they can start something. In fact, that they are more often than not the best method of beginning city planning in a community.

2. That one of the consequences, usually, of the existence of a live citizens' committee is the establishment of an official city planning commission.

3. That a citizens' committée can frequently raise the necessary funds and produce a city plan and hand it to the official Commission when the city government itself is too immersed in the routine administration of a city to think in terms of broad city planning or future city development.

4. That the logical agency for an educational campaign and publicity for city planning is a citizens' committee, first, last and all the time. The official city planning commission can do something in this direction and should do more than is usually done, but because of its very nature the citizens' committee is in a better position to act and is better qualified for the education of the public.

An investigation of the work of a larger number of citizens' committees and a more thorough study of differences in aims, organization and results would no doubt warrant other conclusions of importance. Such a study would disclose certain principles of value and be suggestive and instructive in many ways, although it would be an error, I believe, to look forward to anything approaching a set plan of action for local communities or a standardization of methods. In such a movement as city planning the local conditions prevailing in each city are different, and the best plan of procedure will be one based upon and reflecting those conditions.

The foregoing is an abstract of an address by Mr. Nolen at the 16th National Conference on City Planning at Los Angeles, Calif., April 7, 1924.

USE OF LEAD SUBSTITUTES IN PIPE LINE CONSTRUCTION

By L. A. Geupel, Director Water and Sewer Department, Indiana State Board of Health, State House, Indianapolis, Ind.

Water works men have for over ten years showed considerable interest in the use of the compounds such as leadite, metallium and others which lower the cost of laying bell and spigot pipe in the cost of material used and the labor employed in caulking the joints. As far back as 1911 there was a symposium on leadite in the American Water Works Association. It is my opinion that with proper use, and under ordinary conditions lead substitutes are being used with a saving of cost to the water works men, especially on those sizes including 16 in. cast iron pipe under normal constant operating pressure.

Sulphur Compound Base

Lead substitutes such as I have seen used, including leadite and metallium have as their base sulphur compounds. Leadite is furnished in the powder form, packed in sacks and drums of 100 lbs. net weight and the metallium I have seen used was furnished in a granular pea size packed in 100 lb. bags. Both substitues melt at a temperature easily obtained by a wood fire around 240 deg. F. At higher temperatures both substitutes thicken into a pasty black mass which must be cooled before it can be poured into a joint. Any kettle can be used but on the work I was on the kettle and furnace together with the light ladles were obtained from the company furnishing the material for the joints. These melting furnaces were light in weight, easily handled, and provided with lids so that a fire could be readily smothered. The ladles were much lighter in weight than those used for handling lead. In close touch with an experienced man from the metallium company it was soon learned that care must be taken so that material is not overheated while pouring joints, flames must not get near the mass and an attendant should stir the mass continually to keep the material at even temperature in the kettle.

Characteristics of Materials

It is possible with the placing of new material in the pot to pour a joint with some of the material unmelted which may make a bad and porous joint. Fires do not happen frequently, but with carelessness on the part of the attendant they will occur. Those fires give off strong sulphur dioxide fumes which are suffo-

cating, but the fires are easily extinguished by placing fresh material on the surface of the molten mass or placing lid on kettle.

As I remember on first melting a quantity of leadite or metallium considerable froth, bubbles and scum appear which must be stirred out, and with constant stirring an even mass is obtained in a short time ready to be used. The lead substitute when ready to be used becomes almost like a thin black oil and is somewhat thicker than molten lead.

Running Joints

In running joints it is always necessary to have at least a 6 in. pouring gate above the top of the joint to give sufficient head to fill top of joint. In analyzing the cooling of a joint poured with one of these substitutes the material touching the cool pipe soon chills while the center remains liquid and you may notice that the center of mass in gate pulls down in a core due to a shrinkage of material on cooling. This center core may extend down into pouring gate several inches and farther if the joint is not properly yarned or a leak occurs, and if the hollow core extends into the joint itself it means that an air pocket is probably formed in the joint weakening it, which may cause trouble. It has been my experience that similar to lead all joints should be made with one pour so as to reduce the hazard of a porous joint. These pouring gates can be broken off easily by a light tap toward the bell of The pouring gate moulds are usually of oiled paper and I believe it is ordinary practice to buy these from the company furnishing the material. The pouring gates can be collected, the oiled paper removed, broken up, and melted again, so the material is not lost. Care must be taken that no dirt goes into the melting pot. Home-made pouring gates usually result in the sticking of paper to the material used.

In yarning a joint it appears that dry braided hemp is used to advantage. The yarning does not have to be made as tight inasmuch as the material is slightly thicker and lighter than molten lead and will not carry inside the pipe so readily.

Testing

In testing a pipe line with lead substitute joints some inconvenience may be caused though I have seen lead-caulked lines tested likewise, that is in a ditch before backfilled. A line with leadite or metallium when placed under pressure may show considerable leakage at first, but with properly made joints this leakage should stop in 24 hours or less time, this means that ditches may have to be left open longer if the test is made. I saw one stretch of several thousand feet of metallium-poured line become tight in three or four hours. In cases of leakage which are weak joints the water must be taken out of line and the joint material removed, which can be done easily with a narrow chisel, the joint made dry which may be inconvenient as water may have to be pumped from ditch, and a new joint poured. I never had much luck in pouring half or a third of a joint with a lead substitute. Water in the line is bad for metallium or leadite and many leaks we discovered were on the bottom. With lead leaks in many instances a recaulk job may stop them, but with a lead substitute it seemed best to tear out old material and pour new joint. Leaks the size of a straw and even the size of a pencil may take up with leadite or metallium, depending on the depth of material in the joint. Joints must be poured by men experienced with the use of lead substitute, as amateur work may cause a higher cost due to digging up the line again.

Experience with Metallium

Most of my experience was with metallium at Ironwood, Mich., on five miles or more of 16 in. force main and approximately a mile of mains on plant site laid under all conditions. The labor was at the start inexperienced, the pipe line was laid through rock, peat bogs, marshes, and clay ground, and the weather ranged from summer to 8 and 12 deg. below zero. The pipe line consisted of all classes of cast iron pipe, namely B, C, D, and E, including about a mile of Class A at the plant. The operating pressure on this pipe line varied from 265 to 300 lbs. at the plant to 100 lbs. in town. I have seen an electric knock out on the pumps which caused a surge or hammer of 325 lbs. at the plant. The Ironwood installation was constructed and operated under Alvord, Burdick and Howsen's supervision. I was employed as their resident engineer on this work.

Advantages and Disadvantages in Use of Metallium

I would like to give the advantages and disadvantages I experienced at Ironwood with the use of a lead substitute. The purpose of this discussion is to place clearly before water superintendents

all the phases of the use of lead substitutes so that they may know when to use the material. The advantages in the use of lead substitutes are:

1. It lowers the cost of laying pipe lines materially.

a. I have been informed that one ton of leadite is equivalent to four tons of lead when joints are made the same depth with either material.

b. Lead substitute joints require no caulking which saves back breaking, high priced labor.

c. Lead substitutes are easier and lighter to handle.

d. Lead substitutes are easier to melt, and fuel and time are saved at the furnace.

e. It is not necessary to dig out large bell holes.

f. Work progresses faster which means a saving in the laying gang.

g. Joints are easier yarned and do not have to be yarned so tight.

The disadvantages in the use of metallium are as follows:

1. A slipped joint caused by a strain on the line may have to be repoured when a lead joint can be recaulked without taking water out of line.

2. Sometimes lead can be poured in a damp bell hole, but the lead substitute joint must be dry.

3. Metallium joints would not stand any movement of line under hammer or pressure. Lead caulked lines have more flexibility.

4. Most of the leaks on bottom of pipe due to material not traveling around, showing that yarn was not packed at bottom.

5. Metallium joints would not stand weathering in the open. Material flaked off under freezing conditions.

6. Due to leakage at first the back filling may be held up for test.

7. Suction lines leaked air with metallium. Showing material porous, and perhaps not advisable to use material on suction lines.

In my opinion the advantages of the use of the lead substitutes overshadow the disadvantages in distribution system laid in dry trench operating under normal pressures. I am not familiar with the leakage under pavements used in heavy traffic. At Ironwood on the five miles of force main a number of leaks occured due to winter work and inexperienced labor, but in the main after leaks were repaired the line gave very good service and stood the water hammer and hard usage very well. I have had frequent letters from the plant engineer at Ironwood and he has never complained on the force main so presume the line is in good operating condition.

(The foregoing paper was presented by Mr. Geupel at the recent annual meeting of the Indiana Sanitary and Water Supply Association. At the request of Mr. Geupel the following discussion of the foregoing paper was submitted by George McKay, President of the Leadite Co., Land Title Bldg., Philadelphia, Pa.—Editor.)

The Use and Characteristics of Leadite

"It may be interesting to water works men to know that leadite has been used for making joints in all sizes of cast iron bell and spigot water mains, ranging in sizes from 4 to 60 in. in diameter, and under all pressures and conditions encountered in water works construction. There are many places throughout the country where leadite is used under working pressure exceeding 200 lbs. per sq. in. In many cases, test pressures have been made 500 or 600 lbs. per sq. in., and I know of a case where leadite joints were tested as high as 1,000 lbs. per sq. in.

"When making leadite joints, we do not recommend (and we consider it bad practice) to pour a joint from the melting pot just after a fresh supply of leadite has been added to the melting pot, as some of the unmelted or powdered leadite, which has just been put into the melting pot, may get into the pouring ladle or pouring pot and thus be poured into the joint and probably cause a defective joint. The leadit should be thoroughly melted, free from froth, bubbles or foam, and very liquid before being poured into the joints.

"Fumes coming from the melting pot are a sure indication that too much heat is applied under it, and is a signal to reduce the amount of heat. Leadite does not require half the heat to melt it that pig lead needs. The tendency with a pig lead user is to apply too much heat rather than too little, and he is usually surprised at the small amount of heat necessary to melt leadite.

"When leadite is ready to pour, it has a mirrorlike surface, which will reflect your image so clearly that you could shave yourself in a potful of molten leadite. There should be no froth, foam, or bubbles, and the leadite should be very liquid, and flow freely around any size joint. The leadite should be kept well

stirred during the melting, and particularly before the joint is poured.

"As leadite is so much lighter than pig lead, we recommend the use of a metal pouring gate to give a good head to the leadite and to insure top of joint being completely filled. These gates are made of about 20-gauge metal, and with ordinary care can be used over and over again.

"We always recommend that the joints be yarned tightly to insure yarn being driven back against the bell or hub shoulder, and thus make sure of an even depth and thickness of joint, and eliminate whiskers and loose ends of yarn from protruding and causing leaks, and also prevent any chances of the molten leadite running back and getting ino the pipe. Leadite will flow into a very small space or around a very thin joint. Mr. Gwinn of Terre Haute and Mr. Toyne of South Bend in their remarks have called attention to the advantages and economy of using braided hemp. The use of braided hemp makes it very easy to get an even thickness of joint, there is no waste to it, and it permits making up the joints rapidly. Water works superintendents who use braided hemp would not think of going back to the use of a loose, twisted jute for making up joints.

"The characteristic of a leadite joint becoming tighter the longer it is in service is an excellent feature. Hagerstown, Md., some time ago made a water waste survey in which they were able to segregate that part of their system laid with leadite and the part of their system which had been laid with lead. Their water waste survey showed that the leadite part of their system was tight, and on the part of their system laid with lead they found leakage of 600,000 gals. per day, which they had to correct.

"Unless a joint is leaking badly, it should take up and become tight itself, but if occasion would require cutting out part of the joint, this should be dovetailed so that the leadite when poured will take a firm grip. Leadite will adhere to itself or the space could be caulked up with some lead wool.

"In regard to wet joints, leadite is frequently used where they have considerable quantity of water to contend with in the trenches. The water department of Atlantic City has been using leadite for a great many years, and they do not have to go very deeply in their trenches before they strike water. In using leadite, it is only necessary to keep the water down until the joint is poured and until the caulking is completed.

"Men with ordinary intelligence should learn to use leadite with a few hours' instruction. In fact, a great many places do not have any difficulty whatever in using leadite by following the printed instructions.

"In regard to slipping of joint, it is of interest to know that a thrust test was recently made at Seattle, Wash., with leadite joints and pig lead joints, and the leadite joints stood three times as much thrust as pig lead joints.

"Leadite will not blow or splutter when poured into wet joints, but pig lead will blow which is dangerous and likely to cause injury to the man.

"In regard to movement of leadite joints, we have taken a line of 6 in. pipe, 72 ft. long, and deflected it 5 ft. 9½ ins. Leadite is used over bridges where the vibration is severe. Youngstown, O., has a 12 in. line, over 500 ft. long, crossing a bridge where the working pressure is 105 lbs. per sq. in. They have another line of 16 in. pipe, 970 ft. long, crossing a bridge, and numerous other places have bridge lines which are subjected to severe vibration. Leadite is also used under railroad tracks by water works and also by the railroad companies themselves. Leadite is also used quite extensively in the coal mining districts, where you appreciate they have considerable settlement and movement of the lines.

"You say that most of the joints on the line you laid with a jointing material leaked at the bottom of the pipe. With leadite it is usually the reverse, as any leakage usually occurs at the top of the joint, as leadite will flow easily around any size joints from 4 to 60 ins. in diameter if it is properly melted and there are no obstructions in the joint.

"You say the jointing material you used would not stand weathering, but leadite has been used in a great many places across bridges, some of which I referred to before, and we have not had any complaints on leadite in this connection. There should not be enough leakage to prevent backfilling of the lines. Leadite has been used with success on suction lines. There are a great many miles of pipe laid with leadite in a great many cities under permanent pavements where the traffic is heavy."

EXPERIENCE IN SNOW REMOVAL IN HUMBOLDT COUNTY, IOWA

By K. J. Smith, County Engineer, Doan Block, Humboldt, Iowa

The question of snow removal from the public highways has in the last year or two developed into one of the most important factors in economic maintenance, especially in the Northern portions of Iowa, and all of Minnesota, Wisconsin and Michigan.

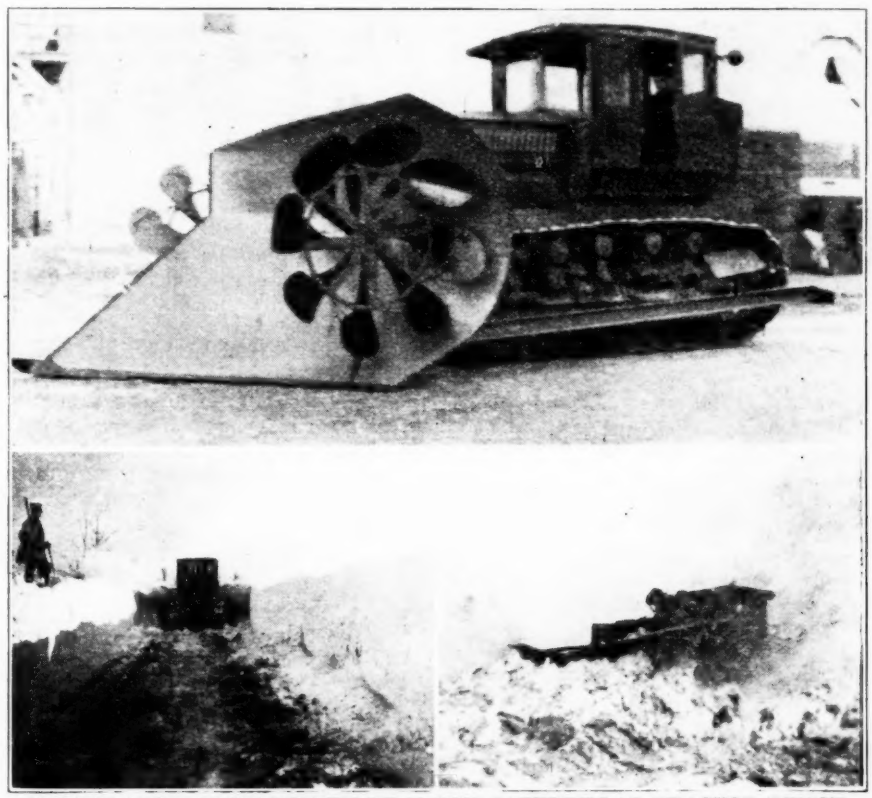
We find that as our investment in highway improvement increases, our problem of safeguarding that investment by more thorough methods of surface protection becomes increasingly great. This is especially true of our gravel roads which as yet constitute our main arteries of traffic in the States mentioned. We find that in the places where the snow has drifted and allowed to thaw, our surface must be entirely replaced. We therefore have tried to accomplish snow removal as speedily and economically as possible.

There are several methods of accomplishing the desired result among which are prevention of drifts by means of snow fences, removing the snow with blade graders and by push plows and rotary plows. All of these methods have their merits under certain conditions and possibly the best of these mentioned is the snow fence, as the snow can be kept off the roadbed entirely when properly placed.

However, there are times when some type of plow becomes essential and that is the condition which confronted us this winter on the road system of Humboldt County, Iowa.

After investigating the different kinds of plows which were on the market at that time we decided that a rotary plow of some kind was the only type of a machine which could cope with all the conditions found upon the roads in Humboldt County. Our roads were practically impassable, being blocked with huge drifts some of them 8 ft. in depth and a quarter of a mile long.

We had tried shoveling early in the



ROTARY SNOW PLOW DRIVEN BY 10-TON CATERPILLAR TRACTOR REMOVING SNOW FROM HUMBOLDT COUNTY, IOWA, HIGHWAYS.

winter and of course the snow that was moved in this manner was piled along the edge of the snow cuts in such a way as to catch all subsequent snows and drift them still deeper than the original drifts. Consequently, our first thought was to procure some machine which would eliminate this difficulty.

The plow which we purchased was a lateral type rotary, which would clear a path 12 ft. in width, and was attached to the front of a 10-ton "Caterpillar" tractor. This type of plow takes its rotary power directly off the crank shaft of the tractor and is easily operated by one man. With it, we cleared the 42 miles of our primary road system in a week. We cleared a drift 7 ft. deep and 600 ft. long of snow and ice, that teams had been driving over, in 58 minutes.

CARE AND MAINTENANCE OF CONTRACTORS' EQUIPMENT

By R. E. Brooks, 50 Church Street, New York, N. Y.

The general subject of the Care and Maintenance of Contractors' Equipment is rather a broad one to try to cover in an adequate manner in one brief paper.

It may be stated without much danger of contradiction, however, that the average contractor does not take as good care of his machinery as the initial and maintenance costs would warrant.

There is scarcely a road or a building job where one may find every piece of a plant in the best of condition or in which one may find the equipment thoroughly cleaned each night and where each piece of machinery has been thoroughly oiled and greased, ready for its maximum's day's work.

Equipment Much Neglected

When a job is completed, it seems to be very common practice to leave equipment scattered all over the place for a much longer period than is necessary. One contractor told me the following which well illustrates the point:

"A contractor was doing some road work in ——— County, and found that he needed a small concrete mixer to complete a part of his work. The superintendent in charge discovered a comparatively new concrete mixer along the road which some contractor had left there the year before. It was with great difficulty that this contractor ascertained the name of the owner of the mixer, in order to pay rental for its use. Finally, this information had to be obtained by 'phoning the manufacturer's agent to look up his records to secure the name of the owner."

Many contractors make the mistake of pulling machines into their yards after they have completed a job or at the end of a working season, and then doing nothing to protect the machinery from the weather; and they make no effort to put the equipment into condition for the next job.

It is a well known truth that any piece of contractors' equipment will not only give a greater return in every day operation, but that its lift will be very materially lengthened if better care were given it while on the job, better protection were provided when it is removed from the work, and if during the time it is idle it is thoroughly overhauled and repaired.

Suggestions for Care of Equipment

The following are a few suggestions for the care of equipment at the end of a job or at the end of a season:

The machine should be carefully cleaned and all accumulations of concrete and dirt completely removed. All bearings should be given careful inspection and taken up where necessary. Wherever bearings cannot be made tight by removing shims, they should be rebabbitted.

All missing and broken grease cups should be replaced.

Cables should be thoroughly cleaned with kerosene or light oil and then covered with a heavy grease having a tar body. Badly worn cables should be replaced.

Gasoline Power

To clean the water jacket, take 2 gals. of hot water, to which has been added all the common washing soda that the water will dissolve. Draw off enough water to accommodate the solution and place it in the engine, let it run for a few minutes. Then drain the engine and flush out the water jacket thoroughly with fresh, clean water. Grease and oil the inside of cylinder, the piston, all shafts and bearings.

Steam Power

Drain the boiler and when dry, remove the safety valve. Pour in about a gallon of cylinder oil, then fill the boiler with water and after completely filling the boiler, drain out all of the water again. This will leave a coating of oil on the inside of the tubes and shell. Replace the safety valve.

Paint the inside of the fire box with heavy oil, remove the hood from the boiler and brush the tubes with a wire brush; swab the inside of the tubes and

hood with an oiled rag or waste; paint the outside of the boiler and hood with asphaltum paint; cover the top of the boiler with canvas, tying it securely around the boiler.

After the machine has been inspected and overhauled, coat it with heavy oil or paint. If possible, store the machine in a building or cover it with a tarpaulin to protect it from the weather.

What has been said so far is more or less common knowledge to most experienced contractors, but it is of no harm to repeat these recommendations in the hope that it will inspire someone to give this most important subject of the care of contractors' plant a little closer supervision.

Effect on Bidding Costs

This subject with its attendant costs of ownership may be a contributing cause of the great difference in the bids on road jobs these days where it is not uncommon to find as much as $30,000 or $40,000 difference between the high and low bidders on a project amounting to around $150,000.

It will be admitted that the item of equipment is a very large and important one to consider in making an estimate in these times. With the present high and ever-increasing cost of labor, it is to the contractor's interest to utilize as much and as efficient labor-saving machinery as he economically can.

Such items as the "economical life" of a piece of a plant and items of depreciation, interest, shop repairs, field repairs, storage incidentals, insurance and taxes are all a part of the annual cost or expense and must be taken into consideration if the contractor is to figure his job to make a profit, and in order not to "kid" himself with a book profit on one job and then wake up to the full realization of the true situation on his next operation.

Studying Equipment Costs

It therefore becomes a very important matter to make a most thorough study of the best method of keeping equipment costs as well as the best methods of caring for machines purchased.

Mr. Ward P. Christie, research engineer, has prepared under the direction of the executive board of the Associated General Contractors of America, a very interesting equipment charge schedule, which will act as a very good guide to contractors. He goes on to state that some of the items mentioned above, such as depreciation and repairs, vary for different machines, and in order to establish total costs he has listed most items entering into contractor's plant giving the average economical life and the other features which go to make up the total of annual equipment expense, of "cost of ownership."

Mr. E. A. Saliers, in his book on "Depreciation Principles and Applications," published by the Ronald Press Company of New York, mentions three principal methods of establishing equipment charges:

Sinking Fund Method

By this system an amount is set up against each piece of equipment purchased, which, when set aside, plus interest compounded annually, will equal the original purchase price of the machine at the expiration of the life of usefulness of the machine.

Reducing Balance Method

This is the method of charging off a constant percentage on the ever-increasing balance and continuing this till the value is equal to salvage.

Straight Line Method

Here is a uniform percentage established each year for the period of economical life. This is undoubtedly the simplest method and lends itself most readily to changes in percentages as experience may suggest.

Various Items

The items which constitute the cost of ownership should all be given very careful attention during the progress of any job in order that accurate data may be collected for estimating purposes on future work.

The "economical life" of a piece of equipment may be said to be that period of time from the purchase to the time when its salvage value is approximately 25 per cent of its cost.

Interest on investment must of course be taken into account and a fair percentage would be 6½ to 7 per cent.

Shop repairs may range all the way from 20 to 25 per cent, depending on the nature of the machinery, the work it is called upon to do, and the quality of the equipment purchased.

The item of field repairs may be carried on the books as a separate item or may be combined with that of shop repairs. "Field repairs" is likewise a variable item and depends upon the same general factors as shop repairs.

Storage and incidentals will usually amount to approximately 3 per cent and must be taken into consideration in an

accurate total of annual equipment expense.

Insurance and taxes will amount to from 2 per cent to 4 per cent and the total of all items of annual cost to be charged against a piece of equipment on each job on which this equipment may be used may range all the way from 25 per cent to as high as 100 per cent.

A great deal of good judgment must be applied in keeping these costs. For instance, if a shovel were used constantly in excavating hard material, the total percentage charge might be greatly increased.

Influence of Specification Changes

Changes in specifications may very materially affect values and may greatly increase depreciation charges. We have a very good illustration of this in concrete road building today. Where formerly aggregates were allowed on the subgrade and no batchmeter required, a 10-E or a 14-E paving mixer could mix all the material which a wheelbarrow charging crew could bring and put into it.

The advent of the batchmeter and changing of the specifications requiring that no material shall be placed on the subgrade, at once made it necessary to use larger size pavers and this, of course, cuts off a large market for the smaller sizes, limiting the field for this equipment and thereby greatly increasing depreciation charges.

I do not need to tell how this one change in specification affected values on certain belt feeding conveyors. It caused them to pass immediately from an item of value to practically junk value in a very short space of time.

When some state changed to the building of half-width roads, a change had to be made by the paving mixer manufacturers to accommodate this new method of construction, thereby greatly affecting the second-hand value of certain sizes of machines which could not be used under the new conditions.

The same situation applies to the item of road forms. One state has recently changed its specifications and now requires a new set of forms on every new job, due to subgrade conditions and the use of a heavy finishing machine.

Change to Gasoline Drive

A similar condition is noted in methods and machinery throughout the road building industry. Take for instance the rapid changes taking place at the present time in power plants on contractors' equipment. I happen to know the facts regarding our paving mixer sales. Where we were three years ago selling 80 per cent steam power on paving mixers, today our sales are about 90 per cent gasoline power.

Since the old-maid twins, known as "Supply and Demand," never sleep and are always up to date in their ideas of values, it is readily realized that such a complete reversal in the demand for gasoline must necessarily adversely affect the demand for steam power, greatly increasing the depreciation on used steam plants. This same tendency is true in many lines of contractors' equipment, and is especially noticeable in such equipment as shovels, cranes, drag-lines, rollers, locomotives, loaders, hoists, etc.

The value of the percentage figures given above is therefore dependent upon the experience and judgment of the contractor, superintendent or bookkeeper, who may be responsible for the establishment of these percentages.

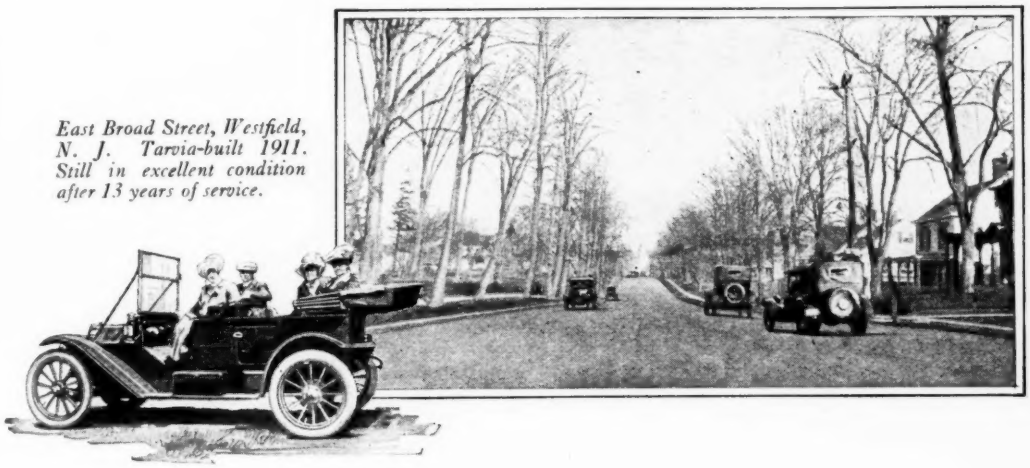
It should also be borne in mind that the cost of ownership goes on whether the machine is in operation or not, because depreciation takes place sometimes faster if a machine is idle than when it is in use.

Conclusion

In conclusion, it may be said that it is a prime requisite for uniform and continuous success in the contracting field that some definite system of keeping annual equipment costs should be carefully considered in figuring work and that each piece of equipment should be purchased with due care and judgment to be sure that it is the best type and best suited to the work, and the one with the longest economical life. The initial cost of equipment is therefore not the most important item to consider, since both factors of economy of operating costs as well as depreciation must be taken into account.

Having actual figures to work with, it will simplify the selection of machinery because it will be clearly shown that it pays to buy machinery which has the lowest percentage of "cost of ownership," and that it is an economical necessity to take proper care of equipment once purchased in order that it may render the most efficient service and thereby make the most money for its owner.

The foregoing paper by Mr. Brooks was presented at the recent annual meeting of the New Jersey Constructors Association.



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